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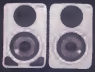

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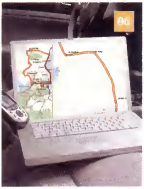

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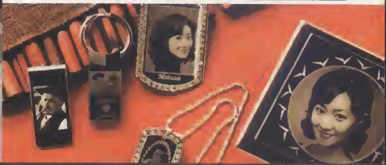

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From the Editor

Jeremy_Kaplan@ziffdavis.com

Eight Months Later

BILL WYLIE

If you promise not to laugh, I'll tell you a secret: The first PC I built took eight months to complete. It was a horrible experience. You can't really blame me, though; for a first building project, it's hard to troubleshoot a defective motherboard. I must have replaced every component in that system before I finally got it right, and when I did, I vowed never to change a damn thing again.

It's true, I learned some fascinating things along the way. I boned up on BIOS settings, front-side bus timings, and memory latencies—facts the average person would have no use for whatsoever. I'm not ashamed to admit that I've become something of a geek: I wear the badge with pride even, knowing that should a memory module sour or a graphics card go on the fritz, I'll be able to fix it. Eventually.

But the bottom line is, eight months is a long time to go without a computer. I took one thing away from all that building, tearing down, replacing, and reconstructing, one simple fact: The right information is crucial. Without the right facts and figures, you're driving a station wagon when everyone else is in Indy cars. Sad to say, we all turn too often to poorly translated manuals or four-year-old books when we reach an impasse.

There's good news, though: You're on the right track now. (Just get out of that car, for God's sake.) Within these pages you'll find everything you need to build it fast and build it right. Detailed diagrams, specific building projects, and even some unusual projects to keep you up at night with visions of components dancing in your head. So read on and enjoy! Drop me an e-mail if we helped, or if there's something you'd like to see in our next issue.

Second confession: The following PC I built still took me a month or so to get right. Which reminds me: Anyone got a spare GeForce FX 5900 I could borrow? Mine's on the fritz. Probably.

—*Jeremy*

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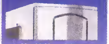
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Front End

HOT GAMES AND OUT-OF-THIS WORLD TECHNOLOGY

The DX9 Games Are Here... Finally

By Peter Suciu

There's a haze filling the air that makes it hard to get a clean shot at the enemy troops huddled on the beach. Something moves in the shadows of an advanced research station, and the sounds of gunfire have you looking over your shoulder. This isn't a scene from an actual battlefield, but thanks to DirectX 9 your senses might not know the difference. A new crop of games feature near photo-realistic graphics, detailed visual effects, and surround sound that make for the best interactive experience yet. It's time for action.

Doom 3

Developer: id Software (*www.idsoftware.com*)
Publisher Activision (*www.activision.com*, $54.99)

What do you do when all hell quite literally breaks loose? If you're on a remote research station on Mars you grab your guns and send those invading other-dimensional demons back where they came! While pretty much every game from the visionaries at id Software could be described so concisely, Doom 3 actually has a much deeper back-story. In fact, it's more of a retelling than a remake of the classic first-person shoot-

continued next page...

Turn your stomach

There's no denying that Doom 3 has some of the best graphics technology on the planet. There's only one question: Why is this nasty demon named "Bernie"? It seems that someone at id has a sense of humor.

Pimp My PC!

Out on the streets, people trick out their Lincoln Navigators (and even their Honda Civics) with custom lights and hubcaps. Here at ExtremeTech, we trick out our computers. Will Knier, the winner of our Crazy Custom Case Mod Contest, went so far as to trick out his hamster. Let's hope the heat of his CPU will keep the little guy warm at night. Let's also hope the ASPCA doesn't get wind of this. For more shots of Will's custom cut job, as well as all the entries in our contest, see ***go.extremetech.com/casemodcontest.***

er. The gameplay remains very straightforward—in the "a whole lotta shooting" vein—but along the way there's a much deeper plot.

Gameplay The action is once again virtually non-stop as you rush like mad through aimless corridors amidst the sprawling research station. A variety of demonic creatures lie in wait around every corner, but this time around you can expect better in-game cinematics and cut-scenes to help tell the story; they engross you in the overall experience too. Many of the original technical decisions for the software engine behind Doom 3 were actually made as long as four years ago, but that doesn't keep this from looking like a spectacular title. Indeed, it will push most aging system to the brink...and even with a fairly robust PC you might spot system chop because of the overwhelming eye candy.

Graphics Visuals aren't the only thing that makes for solid gameplay, but they sure do look nice. The use of bump mapping and lighting effects provide an eerie and entirely alien setting. DX9 support is required for the more detailed special effects you'll witness during the intense carnage, but much of the game has actually been designed for earlier hardware, and close work with ATI and nVidia let id take maximum advantage of what their cards have to offer. Therefore while some of the elements are not entirely photo-realistic (but then again, this is a base on Mars overrun by demons from another universe), the dynamic elements are surprisingly well rendered.

Where textures in past games (including Doom 1 and 2 as well as the various Quake titles) seemed little more than wallpaper on flat surfaces, Doom 3 features much more realized textures. The bump mapping and per-pixel lighting have turned those flat, smooth walls into objects with actual surface details that resemble actual textures. The same results show up in characters as well.

Doom 3, with its unique retelling of a classic, is sort of like going home again. Things have changed a bit, but you'll come away with the feeling that you've been here before. The invasion of demonic creatures has gotten about as bad as it could get...but it makes for one great game.

The gameplay remains very straightforward–in the "a whole lotta shooting" vein–but along the way this instant-classic, first-person shooter has a much deeper plot.

ZOINKS!

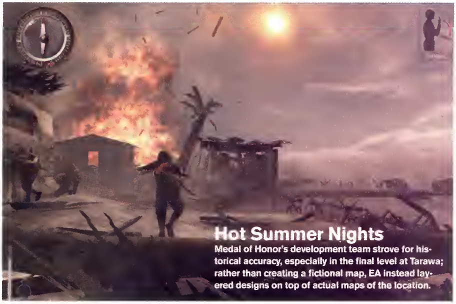
to get the best image quality out of Doom 3, turn on Ultra Quality –if you can. This mode uses no compression at all for diffuse, normal, or specular maps. Since no textures are compressed, many of the levels in the single-player game won't fit into local video card memory unless you have a 512MB card (which aren't on the market yet). Some have reported that the multiplayer levels fit into a 256MB card on Ultra Quality mode, so it may be an option for those with really high-end hardware.

Half-Life 2

Developer: Valve (*www.valvesoftware.com*)
Publisher: Vivendi Universal (*www.vugames.com*, $49.99)

The original Half-Life wasn't so much another first-person shooter as it was a phenomenon in gaming. The 1998 title's rich storytelling really changed the way that other developers would craft their games. Half-Life spawned numerous expansion packs, which presented the story from another character's point of view entirely instead of merely adding a few bonus levels. Additionally, the basic engine became the foundation for several fan-created mods, notably Counter-Strike and Day of Defeat (both of which were eventually released commercially). The story was far from over, though, and now a sequel picks up the action.

Gameplay Once again you'll step into the role of crowbar-wielding Gordon Freeman, a research scientist who must use any weapon at his disposal to stop an alien invasion of Earth. Those who played the original game know that Freeman didn't exactly save the day the first time around, and now the Earth is facing quite an infes-



Hot Summer Nights

Medal of Honor's development team strove for historical accuracy, especially in the final level at Tarawa; rather than creating a fictional map, EA instead layered designs on top of actual maps of the location.

tation of creatures. This time it's up to Freeman to undo the damage, but it won't be easy: In addition to the alien threat there are various human factions with their own sinister agendas. This opens up a need for trust, a cause for suspicion, and plenty of time spent watching your back.

Graphics From the first action-packed level one thing is certain: Half-Life 2 effects need to be seen to believed. The facial animation system is just one of these big improvements; each character can convey a range of emotions and can respond in a seemingly intelligent matter. This makes for a less scripted game and helps immerse you in the experience. But the improvements aren't just pretty (or ugly) faces. The game's Source engine utilizes a radiosity lighting method to simulate the way lights bounce off surfaces, along with a new form of bump mapping that can render an arbitrary number of light sources better than the traditional pass-per-light per-pixel lighting.

Additionally the Valve team essentially rewrote every DX9 shader to take advantage of new hardware capabilities. This includes a technique called parallax mapping, which makes normal mapped surfaces look even more 3D by shifting pixels around to account for the parallax you'd normally see with such detailed surfaces. A new displacement mapping system was used to paint the various detailed surfaces, creating the urban hell Freeman encounters throughout the story; for such a desolate wasteland it's truly a beautiful world.

On the physics side the game also offers numerous enhancements that are sure to improve the gameplay. Built on top of Havok, the Half-Life 2 physics engine allows the inclusion of vehicles, which interact in a realistic manner with a host of other in-game objects and properly balance the laws of friction, gravity, and buoyancy. These various items can themselves be handled thanks to a special manipulator gun that Gordon can use to control various objects in the world.

These graphical and physical improvements make for a very interesting world, but it's the artificial intelligence in Half-Life 2 that really makes the game unique. You'll have to keep your enemies close: The AI has been designed to be devious. But this goes beyond mere scripting. If you do something that a character doesn't like, he'll not only remember it, but he'll do something later that you'll like even less. Of course you do get to carry that big crowbar.

Medal of Honor: Pacific Assault

Developer: EA Los Angeles (*www.ea.com*)
Publisher: Electronic Arts

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(*www.ea.com*, $49.99) Since its release in early 2002, the Medal of Honor series has transitioned from a second-tier PlayStation game into one of the premier franchises for the PC. The game also lead the way in truly recreating the Second World War as it was—rather than relying on fantastical zombies or Nazi super weapons to convey the drama. Moving to a new setting, along with a new engine, is just what Medal of Honor needs to stay fresh and become revitalized. For fans of the original game, Pacific Assault should more than make up for the setbacks of the Breakthrough expansion.

Gameplay The action now unfolds in the Pacific, beginning with the Japanese attack on Pearl Harbor and continuing to the US Marine's assault on the atoll of Tarawa, generally considered the D-Day of the Pacific. The development team strove for historical accuracy in each of Pacific Assault's five missions, which make up the single-player campaign. This is evident in how the game transpires, especially so in the final level at Tarawa; rather than creating a fictional map of the setting, EA instead layered designs on top of actual maps of the location.

Graphics The main improvement over the previous version, besides less linear gameplay, is the new environments that accurately recreate the war in the Pacific. This includes everything from ships in port at Pearl Harbor to the vast openness of the ocean, as well as the rich jungle terrains. Pacific Assault's settings almost seem like a tropical paradise—at least until swarms of bayonet-wielding Japanese Naval Landing Force troops make a desperate charge. Visually the game even outshines the lush jungles of Battlefield Vietnam or Far Cry. The use of lighting effects helps evoke the openness of the settings, while DX9 Vertex Shaders and Pixel Shaders replicate a near photo-realistic look. The rendering engine, which uses a packet-based system, was designed to bundle the game's visual information more efficiently and keep things moving smoothly on higher-end machines.

Skin and cloth shaders have been used to great effect, with a handful of texture maps used at various times to create the right color of the uniforms and even simulate the way light reflects on the cloth. Particle effects help transform the way fire is seen in the game, while a variety of algorithms take advantage of Intel's Hyper-threading systems to better simulate water—something that plays a noticeable role in this game.

The intense nature of the nearly non-stop action is brought to life using the Havok physics engine, which makes for a less scripted game that will better immerse you into the action. And before you get too comfortable after successfully turning the tide, you'll have more to look forward: The developers have purposely left the second half of the war unresolved for the inevitable sequel. **X**

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WHAT'S HOT:
PIXEL SHADER 3.0

By Peter Suciu

In addition to a killer gaming card, owners of the nVidia GeForce 6800, which utilizes the graphics giant's NV40 technology, have support for the next-generation Pixel Shader 3.0 (also called Shader Model 3.0), which is an essential part of DirectX 9.0c. This technology—used in such titles as Painkiller and FarCry—lets developers include every possible detail possible while decreasing the number of active shaders. How's it work? Pixel Shader 3.0 uses dynamic branching so that a single shader can focus on general lighting. The decrease in shader switches allows increased speed for better performance, but also better textures on objects and characters. Owners of ATI cards are out of luck, however. ATI doesn't support the new pixel shader model, concentrating instead on getting the most performance out of the barely supported Shader Model 2.0.

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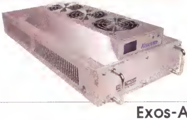

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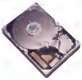

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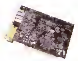

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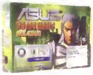

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InsideTech

MX 1000: The First Laser-Guided Mouse

Wireless, good for gaming, and able to mouse on just about any surface, Logitech's MX1000 mouse stands as king of the mouse pad—but is it worth the hefty price tag?

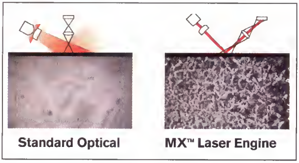
By Robyn Peterson

Welcome to the next generation of computer mice. Equipped with a cutting-edge laser-guided tracking system, Logitech's new MX1000 Cordless Mouse can track movement accurately on your cluttered desk, a glossy magazine, or even your soft, plush couch at home. With that extra level of accuracy, it can detect small movements over surfaces that would otherwise look identical to its myopic, LED-based brethren. Featuring 800-dpi resolution and a 5.8-megapixels per second image processing rate, the MX1000 finally makes wireless tech useable for hardcore gamers.

To capture movement, an optical mouse shines a light against the surface on which it's tracking. The mouse's optical sensor then records the light that reflects back. In a simple sense, an optical mouse has a digital camera that shoots a series of images—6,000 per second in the case of the MX1000. To detect movement, the mouse compares the current image with the series of images it previously captured. Where typical optical mice use a red LED to illuminate the surface they're tracking, the MX1000 employs a laser that provides much more accuracy—20 times more, according to Logitech.

You can experience the benefits of this improved accuracy by mousing over surfaces other than a standard mouse pad: a glossy magazine, a shiny wooden floor, even your shirt. (As I'm writing this article, I'm mousing on a soft couch—and it's flawless.)

Does the average person need to spend $79.95 on this mouse? No. It's a high-end mouse for those PC users who demand top of the line performance. But for all of you performance junkies, meet the first generation of laser-eyed desktop vermin. **X**



Standard Optical

MX™ Laser Engine

How an Optical Mouse Captures Images

To capture movement, an optical mouse will shine a light against the surface on which it's tracking. When the light reflects back into the mouse's optical sensor, it's recorded.

Image Capture Comparison

You can see the difference between an image captured by a standard optical mouse and one captured by the MX Laser Engine in this comparison. It looks like the standard optical mouse needs a trip to LensCrafters.

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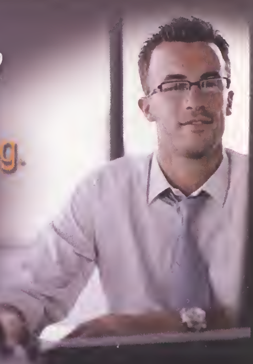

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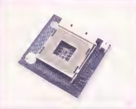

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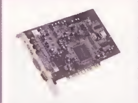

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OutsideTech

Out of This World

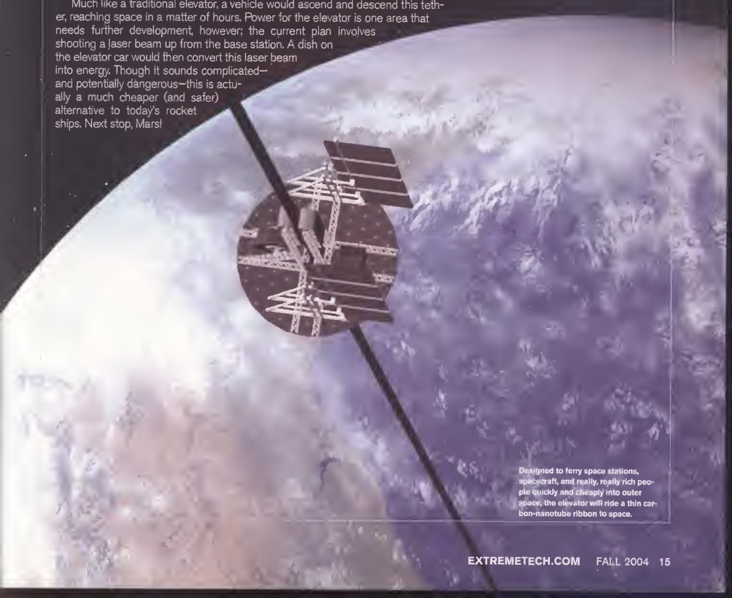
Forty-six year old NASA is looking for a new way to get it up. The space shuttle, that is.

By Matthew P. Graven

In 1895, Konstantin Tsiolkovsky imagined a castle that orbited the Earth and was tethered to the ground. No longer just science fiction, this concept is on its way to becoming a reality. NASA and the Institute for Scientific Research are taking the concept very seriously; this past June, they met at "The Space Elevator: 3rd Annual International Conference" to discuss the latest developments.

The heart of the elevator is a space station tethered to the Earth. A base station located somewhere along the equator would act like an anchor, keeping the elevator fixed in place. The space station itself would maintain a geosynchronous orbit, while the centripetal forces acting upon it would keep the tether taut. The biggest breakthrough so far to making this barely believable concept possibile has been the development of a material strong enough to withstand all the environmental factors yet light enough not to crumble under its own weight: a carbon-nanotube composite. This material can create a tether just 3 feet wide and thinner than a piece of paper, yet tens of times stronger than steel.

Much like a traditional elevator, a vehicle would ascend and descend this tether, reaching space in a matter of hours. Power for the elevator is one area that needs further development, however; the current plan involves shooting a laser beam up from the base station. A dish on the elevator car would then convert this laser beam into energy. Though it sounds complicated—and potentially dangerous—this is actually a much cheaper (and safer) alternative to today's rocket ships. Next stop, Mars!



Designed to ferry space stations, spacecraft, and really, really rich people quickly and cheaply into outer space, the elevator will ride a thin carbon-nanotube ribbon to space.

Remotest R&R

GETTY IMAGES

By Matthew P. Graven

Check in at 3, drop your bags in your room, and then hop over to the in-hotel restaurant for some lunch; you dine casually at a table on the ceiling. Afterwards lounge in the garden as you look out at the Earth This is the future of travel. And you thought Epcot looked dated.

The idea of building a hotel in space isn't all that far-fetched. The real hurdle is finding a safe, inexpensive way to transport tourists into space. But with recent tests of private spacecraft capable of leaving the atmosphere at a fraction of what NASA pays, civilian space travel is moving closer to reality than fiction. It won't be cheap at first, but once built, there will be plenty of eccentric millionaires like Richard Branson eager to book their next holiday.

The actual hotels wouldn't vary much from technology that already exists; the infrastructure will likely resemble that on space stations already in use. Early hotels will be Low Earth Orbit (LEO) spacecraft, which circle Earth at an altitude of about 400 km.

In the early stages, hotels will be built out of cylindrical modules. These can be launched individually and then assembled as needed. As a hotel's business grows, more modules can easily be added, like really expensive Legos. These hotels will gradually pop up farther and farther from the Earth, undoubtedly soon reaching the surface of the moon. The Artemis Project has been researching a self-supporting lunar colony that would offer safari-style trips to the moon.

Many early designs for LEO hotels resemble that in Kubrick's *2001*, with a large outer ring that revolves to provide gravity. Besides addressing certain health concerns associated with a sustained state of zero gravity, this allows untrained visitors to comfortably eat, sleep, shower, and so on.

Zero gravity holds its own appeal, of course. These resorts will provide special sports that make use of the environment: After all, anyone can slam dunk in space. How long until the folks at Fox launch a slew of new zero-G reality shows? **X**

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From: citan x
To: ALL

Jul-13 4:56 pm
(1 of 26)
58587.1

Core PC Tech: Building computers for a new, small business

Hello, this is my first time posting and any help on my problem would be greatly ap-preciated. A relative is setting up a small medical practice and would like your expert opinions on what would be the best setup. Currently this is what the computer guy he is with is telling him to go with:

CPU: Intel 478/P4 2.8-GHz, 512, 800-MHz FSB—$228; **motherboard:** MSI 845 GVM—$99 **memory:** 512MB DDR—$89; **case:** USB 2.0, 300W P4—$70; **drive:** Maxtor 40GB IDE, 7200-RPM—$80; **CD ROM:** 56X IDE—$29; **monitor:** some 17" flat panel—$336; Win XP—$186 **total price:** around $1,150

These parts sound outdated and expensive. What do you guys think? Also, what type of networking setup would you recommend? I know its a lot to ask, but any help would be greatly appreciated.

Email this message

From: Burninbush
To: citan x

Jul-13 6:06 pm
(2 of 26)
58587.2 in reply to 58587.1

I think you'd save some money by going to IBM or Dell or Compaq/HP. Isn't that cost for XP excessive? And also the monitor? A 300w power supply sounds marginal to me. And I'd surely want a DVD burner on at least one of those machines for backup purposes. From what I know of office apps, you don't really need a fast machine.

Email this message

From: LJS
To: citan x

Jul-13 6:59 pm
(3 of 26)
58587.3 in reply to 58587.1

IMO that sounds pretty high cost on some of the components. Most companies like Dell and HP for the name & hopeful support. Dell seems to have some fair offerings & for business a CD-RW for back up is essential. For the same price better can be had. Shucks, I'd build better for that $ amount <grin> Shop around take a look at a few actual boxes at Costco, Comp USA, etc. before he buys. And be careful.

Email this message

TOP TIPS

Tips used for Top Tips come from the ExtremeTech forum and are written by our community.

TIP: Best way to clean my monitor?
Question from KnightsTemplar
"I was wondering what you guys recommend for cleaning your monitor (CRT, not LCD)?"

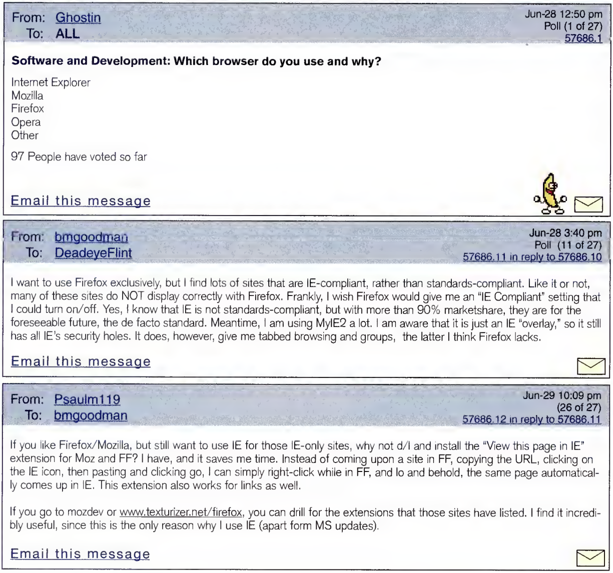
Answer from pctech3
"Anything that does NOT contain ammonia or strong solvents. Windex with vinegar rather than ammonia works great. Ammonia will damage the antiglare coating and make a total mess of the monitor."

Answer from achilles_ny
"Use a moist soft cotton cloth. If water alone doesn't do the trick, use a mild soapy water combo. Refrain from using Brillo pads."

TIP: Minimum wattage for power supply?
Question from shanu
"What should be the minimum wattage power supply for a new system I am going to build:

- INTEL P4 2.80C GHz (HT) or AMD Athlon XP 2800+ (2.083 Ghz)
- 2 x 256MB Kingston DDR 400 (CL2.5)
- Asus Radeon 9600XT 128MB
- Seagate 80GB SATA 7200 RPM
- LG combo drive (16X -52X/24X/52X)

Answer from Sithtiger
"Many people would give you different ranges to choose from, but I would recommend buying the most powerful that you can afford. You want to prepare for the future: When new CPUs and video cards want more power, you'll be ready! Also, an Antec 550 Watt PSU is only about $100 on pricewatch.com! I would not get anything less than, say, a 430-Watt PSU. nVidia recom-



From: Ghostin
To: ALL

Jun-28 12:50 pm
Poll (1 of 27)
57686.1

Software and Development: Which browser do you use and why?

Internet Explorer
Mozilla
Firefox
Opera
Other

97 People have voted so far

From: bmgoodman
To: DeadeyeFlint

Jun-28 3:40 pm
Poll (11 of 27)
57686.11 in reply to 57686.10

I want to use Firefox exclusively, but I find lots of sites that are IE-compliant, rather than standards-compliant. Like it or not, many of these sites do NOT display correctly with Firefox. Frankly, I wish Firefox would give me an "IE Compliant" setting that I could turn on/off. Yes, I know that IE is not standards-compliant, but with more than 90% marketshare, they are for the foreseeable future, the de facto standard. Meantime, I am using MyIE2 a lot. I am aware that it is just an IE "overlay," so it still has all IE's security holes. It does, however, give me tabbed browsing and groups, the latter I think Firefox lacks.

From: Psaulm119
To: bmgoodman

Jun-29 10:09 pm
(26 of 27)
57686.12 in reply to 57686.11

If you like Firefox/Mozilla, but still want to use IE for those IE-only sites, why not d/l and install the "View this page in IE" extension for Moz and FF? I have, and it saves me time. Instead of coming upon a site in FF, copying the URL, clicking on the IE icon, then pasting and clicking go, I can simply right-click while in FF, and lo and behold, the same page automatically comes up in IE. This extension also works for links as well.

If you go to mozdev or www.texturizer.net/firefox, you can drill for the extensions that those sites have listed. I find it incredibly useful, since this is the only reason why I use IE (apart form MS updates).

mends a 480-watt PSU to run their 6800 Ultra. (You don't NEED that much, because I emailed nVidia, who told me that a quality 400-Watt PSU is fine.)

And whatever you do, DON'T BUY A GENERIC PSU!!!! I would highly recommend (not necessarily in this order) Antec, Enermax, and PC Power and Cooling! I know there are a couple more trusted companies but these three are solid to be sure."

Answer from cdkrugjr
"Most manufacturers and a dozen other Internet sites have PS calculators that will do the number crunching for you.

Think about the application and where you'll have the computer. If it's in your bedroom, take a look at PSUs designed to be quiet. The Antec Sonata case has rubber-mounted drives and an autospeed fan that only runs as fast as it needs to. If you're not at all concerned about noise, any high power offering from a reputable maker will serve you admirably."

TIP: How big should a Windows XP partition be?

Question from bigpun
"When creating a partition for Windows XP Pro, how big should the partition be?"

Answer from DrCalEYuga
"There's a 15 Gig bottom line for an XP partition, but it can go into as small a space as 2 or 3 Gigs. I don't think you have enough room for a proper defragging of the partition when it is as small as 2 or 3 Gigs, but some here run XP on as small as 8 Gigs. If you place the Page or Swap file on another small partition, and the Temp files on yet another small partition, you can get away with a smaller OS partition and still have plenty of space to defrag the OS in."

Answer from kgwagner14
"20GB should be substantially more than enough to hold everything you might install. I used to make 10GB parts for my 2K installs, but I found myself getting near the edge sometimes to the point where the defragger didn't want to work."

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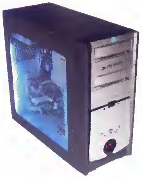

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intel inside pentium 4

PC MAGAZINE EDITORS' CHOICE

MAXIMUM PC KICK ASS PRODUCT

cnet Editors' Choice

PC WORLD TOP 15 DESKTOP PCs

PC GAMER EDITORS' CHOICE

MAXIMUM PC

COMPUTER SHOPPER

- Ok, so maybe we do like to brag.

DIY

WARNING X EXTREME CONTENT

BOOT CAMP

LEARN BEFORE YOU BUILD

First Things First

Before buying another new component for your aging system, be it the smallest light tube or the fastest motherboard you can lay your hands on, stop and ask yourself this question: Does your system really merit an update? Sometimes you're best off biting the bullet and returning to the workshop. Starting from the ground up may be cheaper in the long run too.

The Right Tools for the Job

You're not alone; everyone's tried using their keys to take out a flat-head screw at one time or another. Everyone also knows that it doesn't work, but we keep trying anyway. Here's a better suggestion. Spend 20 bucks and buy a nice screwdriver set, and maybe a few other tools while you're at the store. You'll thank us for it...and so will your keys.

It's Upgrade Time!

At last, the moment you've been waiting for. The mail is here, and so is a shiny package from the folks at fastcoolerdude.com. So dust off your thermal paste, pull out your power screwdriver, and let's get started. Follow out step-by-step guide and every part of your new system build is certain to go smoothly.

Houston, We Have a Problem

It's not all fun and games here at ExtremeTech. (Especially since we had to return those giant 50-inch plasma panels we all had on our desks.) We make the same mistakes you do...sometimes over and over. How do we recover when things go awry? As you'll see from Loyd's recent mishaps, not so perfectly.

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SALVAGE OR SCRAP?

Before you open your case again, screwdriver in one hand and new graphics card in the other, do us a favor: Stop right now. Does that old thing even merit an upgrade? / **Loyd Case and Jeremy A. Kaplan**

Slow down, take a deep breath; maybe even smell the roses. There's one often-overlooked step in the PC upgrade process that too-frequently trips people up: the upgrade plan. If you use an older system, ask yourself whether upgrading is worth the hassle. PC hardware is very inexpensive, but manufacturers buy in bulk and pass the huge cost savings along to consumers. You might be surprised at how cheap simply replacing your system is. If you skip the top-of-the-line system, you can reduce that cost even further. For example, if you've been limping along on an old 200-MHz Pentium MMX system, the power of a 2-GHz Pentium 4 or Athlon XP 1800+ starts to look heavenly…even though they're lower-end systems by today's standards.

It is possible to upgrade a three-year-old system incrementally—if you're willing to upgrade everything. (By the way, the technical phrase for upgrading everything is building a new system.) While building a brand-new system is a great option, it's often easier to buy one. How much will this cost? You can now buy an excellent gaming system for less than $1,000 (less than $1,200 if you already have a decent monitor). And you can get an absolutely killer system for $2,000. Paying more than $2,500 means you're just getting bells and whistles. Airbrushed case, anyone?

Note that buying a new system doesn't mean buying off-the-shelf. If you're inclina-tion is to build a new system, then go right ahead. But if you do, ensure that the new system becomes the beginning of a coherent upgrade strategy. From that point on, you can incrementally upgrade almost forever, although substantial new technologies may eventually force another from-scratch system.

If you've got a system that's less than three years old, you're faced with a more difficult situation. A lot depends on the underlying hardware. The table on the next page looks at three typical examples. If the system you are considering upgrading lacks an AGP slot, stop there. At a minimum, you'll need a motherboard upgrade and a graphics card (if it's a newer system). If you already have an Athlon or Pentium 4 system, an immediate upgrade isn't necessary. But it's wise to plan for future upgrades, because next year's software may demand better hardware.

Plan for your needs. If you're heavily into first-person shooters, the next upgrade on your list should probably be a new video card. But if you're a flight sim buff, you may want to start saving for that new CPU. Make a list of the components in your PC, as well as the type of games you play. This well help you identify the bottlenecks in your system and prioritize your upgrade needs.

Once you've determined whether to keep your system or chuck it, you can start thinking about individual components. If you are upgrading, keep the following rules of thumb in mind.

Note that some manufacturers—Dell and some older Compaq systems come to mind—may not be amenable to large scale upgrades, such as motherboard swaps. These systems use non-standard power supplies or cases, and it may not be possible to drop a new PCI Express ATX motherboard into one of those cases.

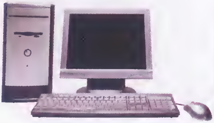
The power supplies that ship in many off-the-shelf systems can be inadequate. A lot of 200W power supplies are out there. If you load up a system with a 3.4-GHz Pentium 4, the latest $400 3D graphics card, and an extra hard drive, you may suddenly be faced with mysterious system crashes. It's pretty surprising how adding a beefier power supply can fix these types of problems.

Also, the most likely candidates for a performance upgrade are the processor, the memory, and the video card. On the B list are newer audio cards, faster and bigger hard drives, and better optical storage. Further down in priority are game controllers (including mice and keyboards), monitors, power supplies, and case upgrades (assuming you already have adequate power delivery). Those last few may be fun upgrades, but they're also less necessary.

GETTY IMAGES

THE MODERN ERA (WELL, NEARLY)

Representative Model:
Gateway Professional S2000
2 years old



Bottom Line: Good Second System

CPU 2.0-GHz Pentium 4

Upgrade With… a faster Pentium 4, which might suffice. But you'll might need a new mobo. If so, get a faster CPU too.

Graphics Card early AGP 4x card

Upgrade With… a 128MB or 256MB AGP 4x card. You can go for a more recent card if you're also upgrading the CPU. Old P4s may max out at 2 GHz, since those used an older socket format. Also, current 8x AGP graphics cards won't realize their full potential.

Motherboard Socket A (Athlon/ Athlon XP) or Socket 423/478 (P4)

Upgrade With… PCI Express socket 775 motherboard if it's a P4 upgrade; socket 939/AGP if it's an Ahtlon 64 upgrade. You may need a new power supply. Budget choice: socket 754 board with socket 754 Athlon 64.

Memory 800-MHz RDRAM

Upgrade With… DDR or RDRAM, especially if you need a motherboard upgrade.

Storage ATA66 or ATA100 hard drive

Upgrade With… nothing, if you've got a 20GB or bigger drive. And if you have an 8x CD-ROM drive or better, no need to upgrade.

Sound Card PCI Sound Blaster 128 or better

Upgrade With… No need to upgrade

Operating System Windows 2000

Upgrade With… Windows XP, of course!

EARLY MODERN-ERA PC

Representative Model:
Micron Millennia MAX 866
3 years old

Bottom Line: Merely Passable PC

CPU 866-MHz Pentium III

Upgrade With… Pentium 4 or Athlon XP. Again, you'll need a new motherboard and memory. You might as well go for a PCI Express system.

Graphics Card Older AGP 2x card

Upgrade With… a newer card, if you can. Be aware that some older 3.3v AGP cards will not run in newer systems that only support 1.5v AGP graphics. If you've swapped the motherboard for a PCI Express board, you'll need a PCI Express Graphics adapter.

Motherboard Socket A or Socket 370

Upgrade With… PCI Express socket 775 motherboard if it's a P4 upgrade; socket 939/AGP if it's an Ahtlon 64 upgrade. You may need a new power supply. Budget choice: socket 754 board with socket 754 Athlon 64.

Memory PC133 SDRAM

Upgrade With… DDR1 or DDR2 if a new motherboard.

Storage ATA66 hard drive

Upgrade With… nothing, if you've got a 20GB or bigger drive. And if you have an 8x CD-ROM drive or better, no need to upgrade.

Sound Card ISA sound card or build-in sound

Upgrade With…PCI card

Operating System Windows 98SE

Upgrade With…Windows XP.

ARCHAEOLOGIC-ERA PC

Representative Model:
HP Pavilion 7370W
Many years old

Bottom Line: Are You Serious?

CPU Pentium MMX 200

Upgrade With… Pentium 4 or Athlon XP. Requires new motherboard and memory. Consider a PCI Express motherboard.

Graphics Card PCI

Upgrade With… PCI Express, which requires a new motherboard of course. Remember, even though there are PCI cards still available, the CPU can't feed them properly, so you won't see much performance increase.

Motherboard ATX, but might be Baby-AT (remember those?)

Upgrade Check power supply. Might need r del. If the current mothe a new case toc req

M old

Up mi

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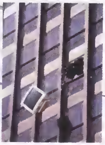
Opera 95 or

Upgrade stems may not run propen

XTIP

Must we really bother going on? If your PC is really *that* old, perhaps you ought to consider this upgrade path...



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ASSEMBLE YOUR TOOLKIT

It's been said that good judgment is the result of experience—and experience is the result of installing the cooler doesn't mean you need to learn in quite that manner. / Loyd Case

Here at *ExtremeTech,* we build a lot of systems. Whenever you read a CPU preview or motherboard roundup, you're reading about the systems we built. Other magazines might plop a motherboard down on a table, plug in the power, storage, and an AGP card, and run a Quake benchmark or two. We build systems from the ground up, in real PC chassis. You do too, right? So get serious: If you've ever tweaked a BIOS, you're not just tinkering around. It's time you spent some money and got the right tools. Here's our short list of the top ten must-have items. Only have money for nine? We guess you can skip the helmet light…

Tech Toolbox

What You Will Need

We use this basic toolkit for every PC we assemble in this magazine. You'll see the toolbox icon before each building project, along with some additional parts where needed.

TOOLS

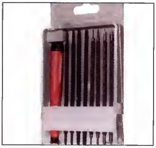
ELECTRIC SCREWDRIVER

The first thing you need is a really good screwdriver with a Phillips head.

The vast majority of screws in modern PCs are Phillips screws. We prefer an electric screwdriver: the Milwaukee 6546. Won't you strip those pot-metal machine screws used in most cases, you may ask? Nope. This model has an adjustable clutch: Use the lowest setting. When the screw gets tight, the clutch disengages, preventing overtorque. The 6546 uses a replaceable 2.4V battery, so keep a spare in the charger. It's also fairly narrow, letting you get into pretty tight spaces. ($90, Milwaukee Electric Tool Corp., *www.milwaukeetool.com*)

MANUAL SCREWDRIVER SET

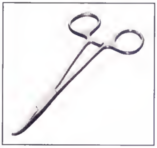
Of course, not every screw is a Phillips screw, nor is every screw easy to reach.



If you need to work in quarters too tight or awkward for an electric screwdriver, we recommend a set of Wiha System 4 compact drivers that fit into a universal handle. This particular drive set has standard, Phillips, and Torx driver blades. The blades are actually quite long, so they let you get into deep recesses. ($38.76 direct, Wiha Quality Tools, *www.wihatools.com*)

FORCEPS

You often have to set jumpers on storage devices and motherboards. This



cheap pair of forceps, available from Radio Shack, makes moving them a snap. (They're sometimes called *hemostats,* which is probably the correct name. But if you ask for a hemostat at Radio Shack, you'll end up with a blank look, not a useful tool.) Forceps are also handy for retrieving the screws or other small objects you will almost certainly drop right between a pair of power regulation capacitors on your motherboard.

($7, Radio Shack, *www.radioshack.com*)

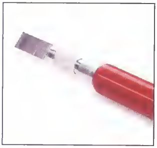
MEMORY CASE

Since we go through so many systems around here, finding the right memory is sometimes a chore. Your best bet is a static-free plastic memory carrier. This particular one even has a lid (let's be clear here—we swiped it from the guys at Mushkin, and we've used it ever since). It beats keeping memory in small antistatic bags that are easy to lose.

SYSTEM PREP

CRAFT KNIFE

Before you get around to installing a motherboard, there's some prep work to be done. For example, if you're swapping in a motherboard, it's likely that the CPU has old thermal grease on it. To scrape off the old stuff, we use a craft knife with a wide, flat blade. This works well for removing thermal goo from a heat sink base or the heat spreader on a Pentium 4 CPU. You should use a narrower, finer blade when performing the same task on a CPU with an exposed die, such as an Athlon XP or Pentium III. ($22, X-Acto Knife Set, *www.staples.com*)



LINT WIPES

You can always use an old T-shirt to wipe the solvent-laden surface, but lint- and static-free wipes are better. We use Surface Guardian Lint Free Wipes from Kensington. ($2, Kensington Technology Group, *www.kensington.com*)

THERMAL PASTE

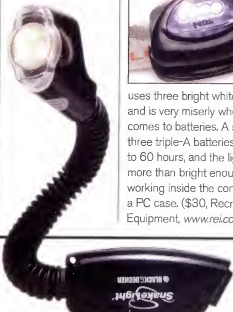
We use Arctic Silver 5. If you're installing a CPU in a system that will not be modified for a year or more, thermal tape is a better solution, but something like Arctic Silver is very handy when you're swapping out CPUs daily. It cleans up easily with solvent—but beware your carpets! ($10, Arctic Silver, *www.arcticsilver.com*)

DEGREASER

There's always a bit of paste remaining, usually around the perimeter of the CPU or sticking to the heat sink base like a space shuttle thermal tile. For that last little bit, a good, environmentally safe degreaser and solvent does the job. We use Blue Shower G3 Cleaner and Degreaser. ($15, Envi-Ro-Tech 1679 General Duty Defluxer, *www.techspray.com*)

FLEXIBLE LAMP

Working inside a PC case can be an exercise in frustration, due to the minimal lighting conditions that exist there. As soon as you get your hands—and head—inside a PC case, all external light is blocked. Contrast is very low, and trying to plug in jumpers or read the silk-screened print on a motherboard is a job for cats or those with better eyesight than ours. We recommend snake lights, which are available from a number of different manufacturers. Our favorite is the Black & Decker SnakeLight Flexible Flashlight, which uses a rechargeable, replaceable battery; it's being discontinued, though, so grab one quick! ($15, Black & Decker, *www.blackand-decker.com*)



LET THERE BE LIGHT

HEAD LAMP

If you're not easily embarrassed, or you don't mind looking like a dork, the best solution is a head lamp. Normally when you think head lamp you think of those massive miner's lamps, but like all things technological, head lamps have evolved. We use a Petzl Tikka lamp. It runs about $30 but uses three bright white LEDs and is very miserly when it comes to batteries. A set of three triple-A batteries lasts 50 to 60 hours, and the light is more than bright enough for working inside the confines of a PC case. ($30, Recreational Equipment, *www.rei.com*)

CHRIS STEIN

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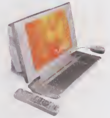

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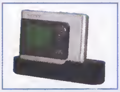

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Install Time
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spend the time, do it right

INSTALLING SYSTEM COMPONENTS

It's been said that good judgment is the result of experience—and experience is the result of poor judgment. Follow our lead to proceed directly to the good judgment category. Just because we've broken the heat sink clip off a CPU socket or crushed a processor by incorrectly installing the cooler doesn't mean you need to learn that way too. / Loyd Case

THE MOTHERBOARD

Without a motherboard, your CPU is a very expensive silicon and plastic keychain. Without a motherboard, that Radeon 9700 graphics card makes a great doorstop. Without a motherboard, there is no PC. But installing a motherboard used to be a pain in the ass. Typical models had zillions of jumpers for modifying CPU clock cycles, front-side bus speeds, floating-point coprocessors, and memory module sizes. Today's motherboards are more complex than ever, yet somehow they're easier to install and simpler to set up as well. Thank God for small favors.

Let's take a look at a few examples of relatively low-cost upgrades. The Athlon XP and 2.4-GHz Pentium 4 are not bleeding edge products, but they should give a substantial boost to older systems. Follow along with us.

1: TAKE INVENTORY

Unpack the box and check to make sure all the components are present. Some motherboards come with a number of small accessory boards, cables, and other items that you may choose not to install. Couldn't hurt to have them all, though, right? In particular, make sure the driver CD and manual are actually in the box. In a few cases, the manual may only come on a CD. But there may be a quick-reference guide that will help you attach front-panel connectors and walk you through other key steps. In our case, we're installing a Chaintech 7NJS Athlon XP motherboard based on the Nforce2 chipset.

2: THE ATX I/O SHIELD

Back-panel I/O shields are as varied as monkeys in a tropical jungle, and their layouts are as erratic and unpredictable. This means that each monkey…er…motherboard will ship with an ATX I/O shield that differs from other boards. The I/O shield is typically a thin sheet of aluminum with holes punched in it to mate with the I/O options on the back of the motherboard. Before actually snapping the shield into the opening in the case, make sure it

Tech Toolbox

What You Will Need

Antec SX835II	Mid-tower computer case with power supply	$100
Chaintech 7NJS Zenith	NForce2-based Socket A motherboard	$135
AMD Athlon XP 3000+	Retail AMD processor with heatsink	$105
MSI 865PE Neo2-PLS	Intel 865PE-based Socket 478 motherboard	$75
Intel Pentium 4 2.4GHz	800-MHz Retail Pentium processor with heatsink	$160
Corsair CMX256A-3200C2	256MB high-performance PC3200 memory chip	$70

Use whichever components you want, of course! Here's a few good deals we've seen recently. Prices are estimates tax and shipping based on our price-comparison engine, *extremetech.shopping.com*

If you bend some pins on your CPU, all is not lost. First, hang your head in shame. Then find a narrow, stiff piece of plastic, like the credit card you used to buy the CPU, and slide it into the row where the bent pins reside. Slowly and gently wiggle the victims back into line.

aligns properly with the connectors on the back panel of the motherboard. (We've seen incorrect I/O shields shipped with certain motherboards.) If you install the shield and then try to force the motherboard to fit, you may end up with a broken connector. More common are unpunched cutouts that mate to an I/O port. Again, trying to force an I/O connector through an unpunched cutout could end badly. Make sure any cutouts that need to be punched out are indeed removed.

3: CHECK THE MOUNT POINTS

Most current cases have mounting holes for only ATX motherboards; some older cases and bigger towers have mounting points for additional motherboard formats. If you have one of these, be sure to install the mounting hardware in the correct holes. In the Antec SX-835 case we're using, there are only ATX mount points. Typically, there are three rows of mounting holes. Full-size motherboards may use all three rows, but many boards use only the first two.

XTIPS

- **If you live in a very dry area** and you upgrade or work inside your PC regularly, consider a grounding strap with an alligator clip. They're available at Radio Shack for a few bucks. Clip one end onto something that's grounded while you're handling sensitive components.
- **Discharge, discharge, discharge.** Before you pick up any component, get into the habit of touching a grounded metal surface. A PC that's plugged into a wall outlet will work (just be sure to touch a metal part, not plastic). Touching the center screw on a wall outlet works too, or a water pipe if one is nearby.

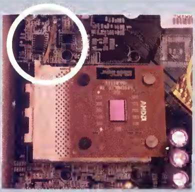
Note that some motherboards may have four screw holes in the first row (the row closest to the I/O cluster). It's usually necessary to use only one of the center mounting positions in that first row. Many other boards have only three screw holes. If you have one of those, *make sure the mounting hardware under the location without a screw hole has been removed!* Otherwise, the mounting hardware could come into contact with a bit of solder or circuit trace, resulting in either a simple ground fault (where the board doesn't boot) or a spectacular failure. Neither is good. Finally, many cases ship with small fiber washers. Don't bother with these: Today's motherboards have insulators around the holes.

4: INSTALLING THE BOARD

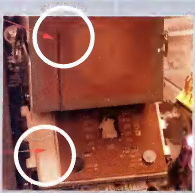
Aligning the motherboard on top of the mounting hardware can be tricky. Tolerances in your PC chassis can best be described as loose, especially if the case has a removable motherboard tray. Your best bet is to install the center screw loosely—don't tighten it. Then install the other screws in a zigzag pattern, much like attaching the lug nuts when you change a car tire. Don't tighten any screws until all of them are in. You may have to wiggle the board a bit to get some of the screw holes aligned.

Another potentially tricky bit is aligning the I/O cluster with the cutouts in the ATX I/O shield. Most shields have some *flashing*—bits of metal still attached from the manufacturing process—and you may have to clip or bend them out of the way to slide the ports all the way through. Typically, serial, game, and parallel ports protrude through

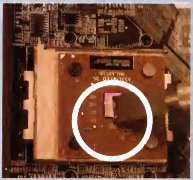
STEPXSTEP



1 INSTALL THE CPU Lift the ZIF lever, align the CPU correctly and ever so gently push down. It should simply slip into the socket. If the CPU doesn't slip in easily, it's either improperly aligned or the lever isn't fully raised. Once the CPU is seated in the socket, lower the ZIF lever until it snaps smoothly into place.



2 LINE IT UP We can't stress this next part enough: Align the heat sink so the groove in the cooler surface mates with the ridge on the CPU socket. Do it wrong and the heatsink won't cool the CPU properly.



3 SPREAD IT THINLY Squeeze out a small drop onto the CPU, then spread it thinly with an edged surface, such as a craft knife. Don't use any pressure to spread the paste, just a gentle motion, like icing the world's smallest cake. Use a bit of lint-free cloth to sop up any excess.

Pentium 4 motherboards and a few Athlon boards also require an additional four-pin, 12V power connector called the ATX12V. (Never let it be said that enginneers lack imagination...)

the shield while mouse, USB, audio, and FireWire ports remain behind the shield. Once you have all the screws into their mount holes, screw them down. Make sure you don't overtighten. The screws and mounting hardware can strip pretty easily. After you screw the motherboard down, pause for a moment to admire your handiwork.

5: FRONT-PANEL CONNECTORS

Every motherboard has a set of pins that connect to the front panel of your case. These pins usually make connections to the power switch, reset switch, power LED, hard drive activity LED, and internal speakers. Your motherboard may have additional connectors for suspend states and sleep switches, but we haven't seen too many DIY cases that support these. Some makers silkscreen the identity of the connectors onto the motherboard itself, but you usually have to consult a diagram in the manual or quick-reference guide to determine each pin's identity. The good news is that these days the jumpers from the front panel almost always have ID markings. A few years ago, determining the correct jumper was a test of one's puzzle-solving ability. If you have large hands, consider using a pair of forceps.

6: POWER CONNECTIONS

ATX motherboards have a single, keyed power connector, unlike the old AT boards that required twin, aligned power connectors. It's a 20-pin plug with a latching key on one side. Simply align the connector so the locking tab is on the side with the latching key, then push the plug straight down into the slot. Pentium 4 motherboards and a few Athlon boards also require an additional four-pin, 12V power connector. This connector is called the ATX12V connector. (Never let it be said that engineers lack imagination…) A few boards have an additional Molex 4-pin connector—the same type used to attach hard drive power cables. If your power supply lacks an ATX12V cable, then you can use this cable to deliver the 12V power that the Pentium 4 likes to receive.

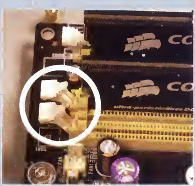
XTIPS

- **Be careful where you work.** Loyd's basement office is carpeted with Olefin—it's actually static-resistant, so he won't build up a static charge just by walking around. Nylon/polyester or wool carpeting and certain types of synthetic floor surfaces can accelerate static buildup.
- **You need a good surface on which to work.** It should be flat, dry, and have adequate space around the edges so you can easily retrieve small items you drop. Trust us: You *will* drop small items.
- **Never, ever handle circuit traces** or, in the case of CPUs, the actual metal pins of the processor.

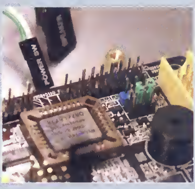
PROCESSOR, HEATSINK, AND MEMORY

Once you've installed your motherboard, it's time to tackle the CPU. Installing an Athlon XP is a little trickier than installing a Pentium 4 processor: The Pentium 4 die sits underneath a fairly sturdy heat spreader that also serves to protect the bare die from all but the most enthusiastic overpressure. You're more likely to break a motherboard than damage a P4. (Bent pins are a potential problem with any CPU installation, of course.)

4 PENTIUM 4 COOLERS RULE The lever-mounted variety is on the left, while the snap-in type is on the right. A P4 heatsink looks huge when sitting next to an Athlon heatsink. They're often much quieter, however, as the fans tend to spin more slowly. Also, they're much easier to attach.



5 LOCKING CLIPS Notice the notch in the DIMM circuit board, along the contact edge. This mates to a key in the memory socket. Once you've mated the notch to the key, slide the module straight down, making sure the DIMM locking clip is pushed out. As you gently press down the clip snaps into place.



6 STUPID LITTLE WIRES You can install the power switch, reset switch, and speaker connectors without worrying about the polarity. The LED jumpers, however, need to be aligned properly. This usually means that the (+) pin is connected to the non-black connector.

There are two types of Athlon XP heat sinks, but the three tab variety is more robust, because if you break a tab you can still attach the heat sink. Our advice is simple: Don't break any tabs.

With an Athlon XP, on the other hand, the bare die sits on top of the organic pin-grid array package (say that twice!).

1: INSTALLING THE CPU

If you look at the top of the Athlon, you'll notice a tiny triangle inscribed on one corner of the package. This triangle matches up with a similar triangle on the underside of the CPU (that's the side with the pins, dummy). Note that two corners have missing pins that correspond to missing holes in the socket itself. The corner cuts act as a key to help you align the CPU with the ZIF (zero insertion force) socket. Pentium 4s have a similar feature, except that the missing pins are both in one corner.

2: INSTALLING THE CPU COOLER

Installing a CPU cooler requires a bit of up-front prep. If you have a stock heat sink with thermal tape attached, it's your choice whether you want to use it. Thermal tape works well if you plan on never swapping out your CPU. Otherwise, if you remove the heat sink later, you could have a sticky mess that's difficult to remove. If this is a system that will remain constant for several years, by all means, use thermal tape. But if you plan on upgrading later, it's best to simply clean off the thermal tape with degreaser and a craft knife.

Next comes the thermal paste. The most popular type is Arctic Silver, which comes in an injector tube. You only need a thin layer; too much paste just oozes out over the CPU and can even ooze between an Athlon XP's capacitors (on top of the CPU package) and create problems. Squeeze a small drop onto the CPU, then spread it thinly with a craft knife. Don't use any pressure to spread the paste, just a gentle motion, as if you were icing the world's smallest cake. Use bit of lint-free cloth to mop up any excess. Then add a bit of the compound to the underside of the heat sink and spread it evenly with a lint-free cloth until there's just a thin, barely noticeable glaze of thermal grease.

The next step gets a bit tricky. Typically, an Athlon XP heat sink clips on to plastic tabs molded into the socket itself. Most use only a single tab on either side; a few lock on to all three tabs. The three tab variety is more robust, because if you break a tab you can still usually attach the heat sink. Our advice is simple: Be careful not to break any tabs.

Another problem with Athlon (and Pentium III) systems is that it's easy to damage the bare die on top of the CPU package. This is especially true if you apply force to the heat sink from an angle in an attempt to align the chip with the CPU socket tab. Some people even use special shims to prevent this, but the only time we've ever destroyed a CPU was when a shim slipped a bit and crushed the corner of a CPU die. No shims here, please.

Attach the clip to one side of the socket, gently set the heat sink on top of the CPU, then apply force *straight down* onto the other clip until it latches onto the tab. This can be nerve-racking, as it requires a fair amount of force. The final step is to attach the cooling fan power cable to a three-pin connector on the motherboard. This applies to only one type of Athlon XP heat sink. Others are easier, offering clips with thumb-operated levers. Some exotic coolers actually attach to mounting holes on the motherboard itself.

There are a few noticeable differences with Pentium Socket 478 4 heat sinks. These Pentium 4 coolers mount into a plastic retainer attached to the motherboard. These retainers typically mount onto the board with plastic wedge pins. If you examine a Pentium 4 cooler mount, you'll see small risers with a small, square hole on each corner. Corresponding tabs on the heat sink itself attach to these holes—in fact, they just snap in.

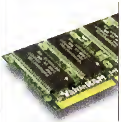
There are two types of Pentium 4 heat sinks. The first and most common type has levers that latch down

NEED FOR SPEED

CPU speeds have jumped up quickly, but so have memory speeds. Faster chips equal greater data throughput....and that leads to better Doom III scores. Note that these are single module speeds. A dual-channel motherboard will aggregate throughput to double the single module rate.

Model Number	MHz clock	GBps
PC2100 (DDR266)	133	2.1
PC2100 (DDR266)	133	2.1
PC2700 (DDR333)	166	2.7
PC3200 (DDR400)	200	3.2

FASTER AND FASTER AND FASTER



If you're stuck using Rambus chips (sucker!), remember that 16-bit RDRAM modules must be installed in pairs (not an issue if you have one of those rare Asus motherboards that support 32-bit RIMMs). Also, 16-bit RDRAM chips require blank termination modules, called C-RIMMs (Continuity RIMMs) in any empty slots.

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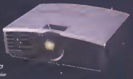

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the heat sink once you've snapped it into the retainer. Snap in each corner post, making sure the lever is raised. Then snap down the lever, which presses the surface of the heat sink against the heat spreader that's part of the Pentium 4 package. The second type of cooler, the "press-on" variety, is even easier. You snap down two diagonally opposite corners, then snap down the remaining corners.

3: INSTALLING MEMORY

Installing RAM is a snap—literally. Motherboards using DDR memory let you install memory one module at a time. A few motherboards now benefit from dual-channel DDR memory, however. When two modules are installed, nForce2 boards gain some additional performance, though you only need to install one memory module at a time. Pentium 4 motherboards using Intel's Granite Bay (7205) chipset gain substantial performance when two identical modules are installed in dual-channel mode, but you can use a single module if you must.

XTIPS

- **If you don't have an antistatic mat,** it's worth hanging onto those large antistatic envelopes that are used to ship motherboards. These are very handy for laying out expansion boards during a motherboard swap, for example. And although we love our geeky head lamp, the area should be brightly lit as well.
- **The area should be physically large enough** to hold your PC case with its guts exposed. You also want space to lay out hard drives, CD/DVD drives, and cables. It's also very useful to have a small organizer for the various screws, nuts, and bolts in today's PCs.

The key point to installing memory is the alignment notch, which mates to a key in the memory socket. Once you've mated the notch to the key, slide the module straight down, making sure the DIMM locking clip is pushed out. As you gently press down on the module, the clip snaps into place. If the clip doesn't snap into place, double-check to ensure you really have the notch aligned correctly: It's off-set from the center of the module. If the clip doesn't snap into place, that's often a sign that you're trying to install the DIMM backwards.

4: FINISHING THE INSTALLATION

It's time to reinstall any expansion cards you want to use. Installing PCI cards is fairly simple. When you reinstall your graphics card, though, remember to make sure that the AGP retention mechanism is properly seated. Next, attach your storage devices to the motherboard. And don't forget the power connections. Sheesh!

Now that you've got your motherboard in place, it's time to power up. Plug everything in: the power cable, keyboard, mouse, and display at a minimum. Then hit the power switch. If you've followed our instructions carefully, you'll be greeted with the POST (power-on self-test) text on the screen. Hit the appropriate key, and set up your BIOS.

Now make yourself a drink: You've earned it. **X**

TROUBLESHOOT THE BOOT

Look, pal, you're not perfect. Believe us: We know. So even even if you think you've installed all your parts perfectly, you can still run into problems when you first boot up. Don't take it personally. Here's a few typical problems and how to solve them:

! Nothing happens when you press the power button.

Uh oh. There are several possible causes. First, check to see if the front panel power connector is really installed correctly; orientation's not important, but make sure the connector is attached to the right pins. If it is, check to see if the CPU is properly installed. Finally, make sure your power supply hasn't given up the ghost. Oh...and we hate to even ask, but...did you plug it in?

! The power supply starts up and all the fans spins, but nothing else happens.

If you're not even getting beeps on start-up, check once again to make sure the CPU is properly installed. Also check that the memory modules are seated correctly. Another possible source of the problem is reversed IDE cables. Finally, check your power supply to make sure it's working. To do this properly, you need to either hook up the power supply to another system or attach a supply that definitely works to the system with the newly installed motherboard. Neither is a simple task, however.

! The system powers up and you hear multiple beeps, but nothing appears on-screen.

Check to see whether the memory and video card are properly installed. Recently, we were greeted with frantic beeping when trying to power up a new system. It turned out that the power cable for the Radeon 9700—which needs external power supplied through a floppy drive power connector—had come loose.

! You get power and can get into the BIOS, but the system hangs on boot.

This can sometimes be caused by a bug in the BIOS. Try resetting it by selecting the "Load Setup Defaults" or "Load Fail-Safe Defaults" option when in the system BIOS. If it still hangs, disconnect the hard drives and remove all expansion cards but the graphics card. Then try to boot. If this works, try installing your PCI cards in different slots. Note that you may simply have a bad motherboard. We've noticed an increasing number of DOA boards in our product testing, and that's never a good sign. Always buy from a reputable vendor who will be willing to replace your defective hardware with working gear.

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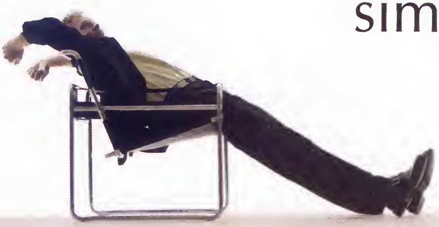

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DIG OUT FROM A DISASTER

Our resident guru tells a tale of woe about a system crash and his efforts to recover, as well as figure out what went right—and wrong. / Loyd Case

This is not a story about backing up your system. I promise. This is a more personal story, about a disaster that struck only a few days ago. It happened to my production system—the one I use to write, edit, and communicate with the outside world. It's a tale of disbelief, panic, denial, and recovery. ABC may have optioned the rights for an after-school special.

It began innocuously enough. My oldest daughter came downstairs to my basement office. "Hey Dad, I need that picture of the dog printed out for class tomorrow."

"Uh, yeah, right."

I popped the CompactFlash card out of our camera and slipped it into the USB memory card reader, a Dazzle multifunction unit capable of reading both CompactFlash and SmartMedia cards. A click of the mouse opened up My System, and another couple of clicks navigated to the folder containing the pictures. That's when the system froze.

I swore—quietly, under my breath (my daughter was hovering nearby, so I couldn't just cut loose). The mouse cursor was still active, but no amount of clicking activated anything. The system had been running for about 12 hours straight, with no hiccups or problems. After fruitlessly trying to bring up Task Manager, I hit the reset button on the front of the case. In a moment, I was staring at the winking text cursor on the screen. It typically shows up momentarily before the video card POST message appears. This time it hung there, flashing in a tantalizing, hypnotic way. I sighed, apologized to my daughter, and sent her upstairs.

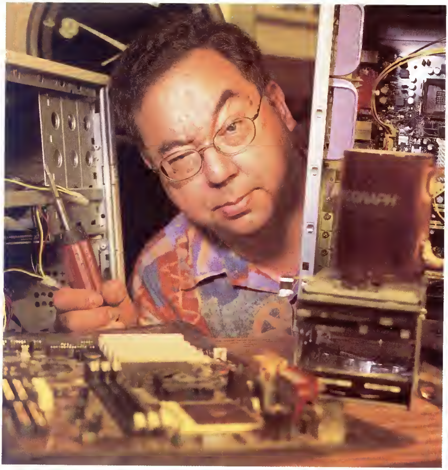
Then I powered down and turned off power to the uninterruptible power supply. After several minutes, I started up the UPS and hit the power button. Several minutes later, I was still staring at the blinking text cursor. A gnawing, sinking feeling settled into the pit of my stomach and refused to leave.

But at that point, I myself had to leave the office, for about half an hour. When I returned, I found myself staring at the BIOS setup screen. I had no doubt pressed the key for the BIOS setup program as one of many random actions taken before leaving. I checked the settings for good measure: Everything looked fine. So I rebooted. Again, the blinking cursor appeared.

I powered down once more and swapped out video cards. As I was performing this task, I noticed that the interior of my PC had collected a fair amount of dust, so I grabbed a can of compressed air and cleaned out all the little dust bunnies. (This is probably something worth doing anyway; your fans will operate better, and your nose will thank you for it.) Then I hit the power button. After a few moments, I was rewarded by three beeps and a blank screen. I muttered some unkind words, fired up another system, and ran a search for Intel BIOS beep codes.

I've mostly worked with Award or AMI BIOSes. When you hear multiple beeps and get no video, the first thing that comes to mind is a bad video card. It turns out, though, that the pattern of beeps I heard indicated a memory error in the first 64KB of lower memory. That sent me back to the PC to swap out memory. The same beep pattern occurred.

The system froze. I swore–quietly, under my breath (my daughter was hovering hearby, so I couldn't just cut loose). When I hit the reset button on the front of the case, the cursor hung there, flashing in a tantalizing, hypnotic way. I sighed.



You've got a lab area, right? With the carcasses of past PC projects? A place to store those extra screws you couldn't find a place for the last time you took apart your PC? Here's Loyd's special place.

LARA HATA

By now I was becoming increasingly baffled and frustrated. So I performed a more careful search of Intel's Web site and uncovered an interesting tidbit: The error usually indicates that some component on the motherboard itself has failed. I sighed. I didn't have a replacement Intel board, but an Asus P4T533-C was squirreled away in my storage closet. I pulled it out and swapped motherboards. After plugging in all the expansion cards and cables, I carefully installed a video card I knew was working and fired up the system.

IT BOOTED INTO WINDOWS.

What Should Loyd Do Now?

Ask yourself: What should Loyd have done? If your answer is, "Loyd should have backed up his C: drive," you win a foil-covered kiddie cigar.

Unfortunately I was too frazzled. It was 2 A.M. by this point, and I kept plugging away. Since I had properly booted, I decided to run CHKDSK on the hard drive. When you run CHKDSK on the boot drive, the disk check must run from DOS, prior to the Windows start-up, so naturally the system rebooted. The disk check passed, but when Windows tried to boot, Windows halted with a `STOP 0x00000027`.

Although it was the wee dark hours of the morning and the fog of fatigue was really starting to grip my overextended brain, I paused for a moment to take stock.

The system didn't really hang initially. It had just taken a long time to get to the appropriate stage of the boot process—the OS boot stage or the system BIOS setup screen, depending on what I'd done. Boot times had become ludicrously long, however: It took 10 minutes to get past the initial POST. Swapping out video cards resulted in system memory errors, which seemed to indicate that a motherboard component had failed. And swapping out the motherboard led to one successful boot. But after a boot and a CHKDSK, I got an error indicating boot problems, possibly with the disk.

My next step was to pop in a PowerQuest DriveImage boot floppy; I use Power-Quest to back up disk partitions. My objective was to back up the C: drive to my physical D: drive, where I had a good 60GB of free space. After booting into DriveImage, I told it to back up the C: drive. Then I received a rude shock, in the form of a DriveImage error that read "Partition improperly dismounted."

Not only couldn't I boot, I couldn't even back up the partition.

By this time it was 3 A.M. It was time to throw in the towel and get some sleep.

A few hours later I was back, armed with an electric screwdriver and a new resolve. I couldn't fix the problem, so I was going to do the next best thing. I pulled the hard drive out of the system and plugged it into another, this time as the slave drive. When I booted that system, I could read the old drive with no

Then I received a rude shock, in the form of a DriveImage error that read "Partition improperly dismounted." Not only couldn't I boot, I couldn't even back up the partition. It was 3 A.M. It was time to throw in the towel and get some sleep.

problems. I immediately backed up key data, mostly game saves and digital photos in the My Pictures folder. Most of the other useful information I'd backed up not long before.

I came to the conclusion that this Windows installation was unsalvageable. I'd wanted to perform a clean reinstall for some time; now the crash, and my subsequent failure to clean up the problem, had forced the choice on me. It had always been an oddball installation, anyway. Originally the drive had held Windows Me. I'd set up Windows XP from a gold master install disk, as a dual-boot on the same drive. As most sysadmins will tell you, this often isn't a good idea. But it's usually not a good idea for the older OS, so I figured my Windows XP would be fine.

Later I'd converted the FAT32 volume to NTFS, then migrated everything to a larger hard drive with DriveImage. Along the way, I'd installed and uninstalled quite a few applications and implemented a number of hardware upgrades. In other words, this particular Windows installation was about as big a kludge as you can imagine. So I did a full reformat of the drive and installed Windows Service Pack 1 and all the latest drivers. I copied all the data I'd saved, installed my key applications, and was ready to go. I plugged in my USB memory card reader and inserted the CompactFlash card.

THE SYSTEM FROZE. Yep, you guessed it. After nearly two full days of system troubleshooting and recovery, I had finally uncovered the root cause of the problem: The USB card reader had gone south, somehow taking out my old motherboard at the same time. This time I unplugged the card reader, then reset the system. Windows booted normally, and I let myself exhale. I then backed up the partition before testing the card reader again. Yep, it consistently hung the system. It didn't matter whether it was plugged into a USB 1.1 hub, a USB 2.0 hub, or directly into a system port.

I jumped into the car, made a quick trip to the store, and returned with a brand new SanDisk card reader. I plugged it in, slipped in the CompactFlash card…and everything worked.

LEARN FROM MY HUMBLING EXPERIENCE. I made a number of errors along the way, and despite years of troubleshooting and systems analysis, I'd made some fundamental mistakes. For one thing, I didn't patiently unplug everything and try to isolate the error. It's very possible that if I'd unplugged all the USB hubs in the beginning the defective card reader would have been left out of the loop, and I could have restored my original system.

The worst mistake of all: *trying to solve the problem when I was exhausted.*

In fact, swapping out a motherboard at 2 A.M., after a full day of work, was not the brightest thing I'd ever done. But in my hubris—hey, I'd done that sort of thing hundreds of times—I plugged doggedly away.

What I also should have realized at the time is that *this was my production system.* I build and rebuild test-beds on almost a daily basis. I'd gotten into a sort of rut, thinking my work system, which has scads of valuable data, was just the same as any other system in the lab. But it's not. It's the production system, and it needs to be sacrosanct.

Do your best not to repair your electrical devices while they're running. If Mr. power cord is plugged in, you stay out.

I'd been saved from my own bone-headed behavior by some up-front preparation, however. For one thing, I have two physical drives on my system. My actual work information—that is, the reviews, feature articles, and graphics that go into ExtremeTech—were on the D: drive. I've learned from previous bitter experience that boot drives tend to go south much more often than secondary drives. So despite the fact that the system had been down for nearly 36 hours, none of my real data was compromised.

I'd also backed up all the important new data, though the previous backup was more than a week old. I had gotten lucky, since I was able to copy the newest information by setting up the drive as a secondary on another system.

There's a saying that goes something like this: *Good judgment is the result of experience; experience is the result of bad judgment.* I now present a corollary to that: *You can gain a lot of experience when you're tired and frustrated.* Sometimes, it's best to walk away from a problem for a few hours. We've all had moments of epiphany about problems we've been wrestling with—and those moments often come when we're doing something totally different. So take a walk, read a book, or go play with the dog. Just don't pull a Loyd. **X**

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BUILD IT

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AMD vs. Intel

/ Jason Cross

Look at all the Web sites from companies that build gaming PCs—Alienware, Falcon Northwest, Voodoo PC, you know the type—and you'll notice that most systems sell for upwards of $2,000, and sometimes more than $3,000. Screw those guys. ¶ A decent gaming PC doesn't have to cost you an arm *or* a leg. We took it upon ourselves to prove that you can build a solid gaming PC for a cool grand, provided you shop around a bit. But is a less expensive AMD chip or one from the nerds in Intel's lab going to get you the best gaming performance? After all, the graphics card is doing most of the work. Read on to see how the chips performed, and which one wins our shoot-out.

Intel:

When it comes to games, the latest Pentium 4s perform better than Athlon XP chips with comparable model numbers. On the other hand, Athlon XP CPUs with higher model numbers are available for the same price as that Pentium 4, and today's games love fast AMD chips. Bus speed is important too: The faster the front-side bus, the faster the overall memory bandwidth—a crucial factor in 3D game performance. In the end, we went with the fastest Pentium 4 with an 800-MHz bus that fit our budget: the 2.4C. We could have gone with something beefier, but that would have meant shortchanging the video card. The Intel comes with a stock aluminum cooler that won't win any major awards for quietness or cooling efficiency among the overclocking crowd, but it's a sturdy and reliable cooler that performs just fine if you don't overclock.

With our CPU picked out, we needed to find the cheapest reliable motherboard that supports 800-MHz bus Pentium 4 CPUs. We settled on the PT880 Neo from MSI, which uses the VIA PT880 north bridge and VT8237 south bridge. This gives us a couple of Serial ATA ports, RAID capability for future growth, plenty of USB 2.0 and FireWire ports, and integrated 10/100 Ethernet. Some people have reported stability problems with Pentium 4s and VIA chipsets, but someone must have worked the kinks out: Our system was rock-solid through all testing, including a little extra stability testing on the side.

AMD:

A Pentium 4 with an 800-MHz bus is definitely faster than an Athlon XP of the same class for gaming overall, but it's often more expensive as well. We were able to afford only a 2.4C GHz Pentium 4, but recent price drops let us put an Athlon XP 3000+ with 400-MHz bus in our second box. The broad difference in performance ratings at the same price point tips the tables in favor of the AMD chip. AMD chips are hard to find solo at a good price; they're often boxed at retail with a CPU cooler. Instead, we went for a chip-only OEM model and bought a separate CoolerMaster heatsink, much like the ones that come with boxed retail processors.

Of course, with a new CPU we need a new motherboard. We went with the Shuttle AN35/N Ultra, based on the nForce2 Ultra 400 chipset. It compares fairly well with the VIA PT880 chipset that our Pentium 4 system uses, but it lacks Serial ATA connectors. As this particular nForce motherboard doesn't use the MCP-T south bridge (with its integrated audio digital signal processing), it's important to circumvent the Realtek AC '97 codec by using a good sound card. In our case, it was a very affordable Sound Blaster Live!

Memory: Memory prices change almost daily, but trend ever downward—you can get quality, name-brand memory for about $40 per 256MB stick, as long as you don't also opt for the really low-latency stuff. Superlow latencies would have been nice, but in our case it was more important to make sure we had 512MB than to have the extra speed. Doing both would have cut too deeply into our budget.

Case: It's not easy to find a really nice, inexpensive case, but the Antec SLK3700AMB has a lot to offer. Its gray finish is appealing enough, and the side clasps and thumbscrews make it easy to get in and out without dragging out your tools. There are two USB ports in the front of the case, just below the drive-bay door. The interior is tidy, without any sharp edges to cut up your hands while you dig around. There's good room inside, for a midtower case with a smallish profile: four 5.25-inch drive bays, a pair of 3.5-inch drive bays, and a hard drive rack that snaps out easily and can hold up to four 3.5-inch drives. This rack even comes with rubber grommets on the screw holes to reduce noise from vibration.

Speaking of reducing noise, the rear fan is one of the large, slower-turning 120-mm variety, which keeps the air-flow up and the noise down. If you want more air-flow, there's space to mount another 120-mm fan in front. The SLK3700 is fairly quiet overall, but our CPU fan made enough of a ruckus to keep us from calling this a quiet PC. It wouldn't be a bad investment to spend a little more on a quieter CPU fan. The

Tech Toolbox

What Does $1,000 Buy?

Component	INTEL	Price	AMD	Price
Processor	Pentium 4 2.4C (retail box)	$140	Athlon XP 3000+, 400-MHz bus	$103
Active Cooler	(included with CPU)	N/A	CoolerMaster CP5-6J31C-01	$13
Motherboard	MSI PT880 Neo	$58	Shuttle AN35N-Ultra	$56
Memory	512MB Kingston PC3200	$78	512MB Kingston PC3200	$78
Case	Antec SLK3700AMB	$64	Antec SLK3700AMB	$64
Hard Drive	Western Digital WD800JB	$61	Western Digital WD800JB	$61
DVD-ROM/CD-RW	Lite-On LTC-48161H	$51	Lite-On LTC-48161H	$51
Graphics	ATI Radeon 9800 Pro 128MB	$190	ATI Radeon 9800 Pro 128MB	$190
Monitor	19" Samsung 950B	$175	19" Samsung 950B	$175
Speakers	Logitech Z340	$32	Logitech Z340	$32
Audio	Sound Blaster Live 5.1	$25	Sound Blaster Live 5.1	$25
Floppy Drive	Mitsumi	$29	Mitsumi	$29
Keyboard	Microsoft Natural Multimedia	$20	Microsoft Natural Multimedia	$20
Mouse	Microsoft Intellimouse Optical	$14	Microsoft Intellimouse Optical	$14
Operating System	Windows XP Home	$69	Windows XP Home	$69
Total		$1,006		$980

Prices shown are estimates before tax and shipping based on our price-comparison engine, *extremetech.shopping.com*

PREVIOUS PAGE GETTY IMAGES

What Enthusiasts Ought To Know About Performance Memory:

Memory is memory, right? Actually, no! Inferior performance memory can wreak havoc on your system. The blue screen of death, software crashes, driver and operating system hiccups—all can be caused by bad memory modules.

As you increase the operating frequency of your FSB, the quality of the system components becomes increasingly important. When the FSB frequency increases, the allowable margin of error decreases, and a small variance outside accepted tolerance levels can result in stability issues and cause system problems like the ones mentioned above. As an enthusiast, you need memory that consistently meets the performance demands of your system.

Crucial's new Ballistix™ high-performance memory line is designed specifically for computer gamers and power users seeking maximum system performance and stability. Featuring advanced speed grades, low latencies, and integrated aluminum heat spreaders, Ballistix™ modules deliver the powerful performance you want and the stability you need*.

Doom 3™ Is Here!
But Is Your Computer Ready?

The geeks in the Crucial Performance Lab have put Doom 3™ to the test! Download the complete test results and find out how to get your system Doom 3™ optimized.

www.crucial.com/doom

But don't take our word for it. Anandtech, the leading online IT source for hardware analysis and industry news, was so impressed with Ballistix™ DDR400 in their August 4, 2004 DDR400 roundup, they claimed it "showed the most incredible timings that we have ever seen for any memory" and went on to award it the Gold Editors Choice for Best Performance. Anandtech.com, editor Wesley Fink said, "Crucial® Ballistix™ is the first memory that we have tested to achieve consistent, stable DDR timings of 2.5-2-2 at DDR500, in addition to the incredible range of usable timings at the most aggressive 2-2-2 timings. What can we say about Crucial's Ballistix™ that does DDR500 at 2.5-2-2-5? The only word that comes to mind is 'astounding'!"

While other memory sellers might offer a cumbersome list of compatible processors and motherboards, Crucial provides the award-winning Crucial® Memory Advisor™ tool, an easy-to-use, searchable memory database. In just three easy clicks, the Crucial® Memory Advisor™ tool finds exactly the right Ballistix™ module for you—compatibility guaranteed.

To find exactly the right Ballistix™ memory for your system and to download the Doom 3™ performance test results visit: www.crucial.com/doom

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*Crucial® Ballistix™ products are tested to meet the published specifications on www.crucial.com/ballistix. Some system configurations may not operate at the published Crucial Ballistix memory speed and timing settings. Overclocking, running your system faster than published speed, or otherwise modifying your system timing may result in damage to computer components.

AMD

ATHLON XP 3000+

UNDER THE HOOD

A good value and an overall fast chip, the XP 3000+ is the second from the top in the Athlon XP line, and a great value. Gamers consider it a solid bang-for-the-buck CPU.

Core: Barton
Barton is the latest Athlon XP processor built on AMD's 130nm manufacturing process.

Speed: 2.0 GHz
The fastest Athlon XP clocks at 2.2 GHz but costs nearly as much as some Athlon 64 chips. The 3000 is the sweet spot for a [illegible] CPU that's not artificially crippled.

FSB: 400 MHz
Couple the 400MHz FSB with a dual-channel nForce2 Ultra motherboard.

L1 Cache: 64K+64K
(instruction + data cache)

L2 Cache: 512K
Substantial cache for a relatively low cost processor [illegible] overall memory throughput.

SHUTTLE AN35/N ULTRA

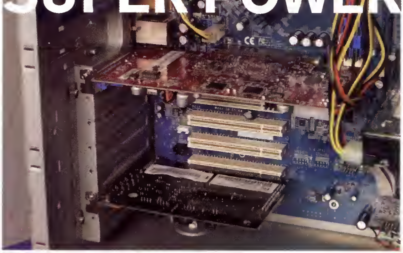
Chipset: nForce2 Ultra 400 + MCP
nForce2 Ultra offers dual-channel DDR400 support, increasing overall memory bandwidth.

Audio: Realtek ALC650 5.1

LAN: Realtek 8201BL 10/100M
The integrated audio isn't as good as a separate PCI sound card but gets the job done.

Upgradeability: Accepts CPUs up to XP 3200+, and up to 3GB of RAM.

SUPER POWER



We managed to squeeze $1,000 of pure gaming goodness into our Antec case, partly because of careful purchasing but also due to the power of today's equipment. And installing the CPU and RAM in the case was a snap too. Finally, it may not have Serial ATA, but Shuttle's AN35/N Ultra is a nice, inexpensive board.

TOP LEFT GETTY IMAGES

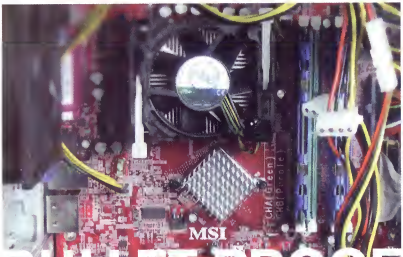
case comes with a 350W Antec power supply, which is sufficient for our purposes here. Again, it's not the quietest one we've heard, but it's not particularly loud, either. Call it your typical 350W power supply. Considering that it comes with a pretty nice case for $75, it's a bargain.

Storage: Capacity is important in a hard drive, but in our budget we needed to find the right balance between price, performance, and size. A Western Digital 800JB drive can be had for just over $60 now; it holds 80GB and has an 8MB cache, which should help with those annoying hard drive accesses during games. It's not the biggest or fastest drive in the world, but it's a solid performer and big enough to hold a dozen games in addition to Windows XP.

DVD: Burning would have been a fun addition, especially with drive prices plummeting so quickly, but it's definitely a secondary concern in a gaming system. Reading DVD-ROMs is not, however: A few games have come out on DVD, which makes installing them a lot easier than when you have to swap several CDs. We opted for a Lite-On combo drive that can read DVDs and read and write CD-Rs and CD-RWs. At only $51, the LTC-48161H achieves quality read and burn speeds and supports all the relevant DAO and SAO modes to do those tricky backups. It's a great little drive at a great price.

Audio: Motherboard-down AC '97 audio is suitable for some systems, but it's just not the best choice for games.

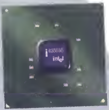
Recipe for powerful gaming: Start off with an Antec SLK3700AMB case, shown empty here. Add a powerful graphics card and a reasonable CPU (With that MSI motherboard and Radeon card, it's awfully red in there). Plug in all those wires, mix with Doom 3 and Far Cry (with a general dose of late-night fragging) and you've got yourself a very time-consuming computer.



BULLET PROOF

There are simply too many compatibility problems with games and AC '97 audio solutions of every stripe, and they tend to eat a lot of CPU cycles when processing 3D sound effects. For around $20 we can pop in a Sound Blaster Live! 5.1 and get better performance and compatibility. Sound Blaster cards are quite thoroughly tested by the game publishers' quality-assurance departments. Just make sure your drivers are up to date. We found a great deal on Logitech's low-end 2.1 speakers, model Z-340. It's only a little 33-watt setup, but it really helped us come in under our $1,000 limit. Good alternatives would be a decent pair of $50 headphones or a low-end 4.1 or 5.1 speaker system for a few bucks more.

Graphics: Fast 3D graphics are an absolute must for anyone interested in playing the latest games. You don't need to spend $500 on the latest video card to get a good experience, though. The Great Deal of the Moment is the Radeon 9800 Pro with 128MB of memory, which can be found online for just over $200 from VisionTek, Sapphire, and ATI itself. It would be great to have 256MB of graphics memory, but that adds about $150. Even with 128MB this card will be a real screamer, though. It's only a notch or two down from the best cards on the



UNDER THE HOOD

Core: Northwood

Speed: 2.4 GHz

FSB: 800 MHz

L1 Cache: 8K

L2 Cache: 512K

MSI PT880 NEO

Chipset: Via PT880 north bridge, VT8237 south bridge

IDE: Serial ATA RAID

Audio: Realtek ALC655

Upgradeablility: Supports CPUs up to 3.6 GHz, and up to 4GB of RAM.

Intel

PENTIUM 4 2.4C GHz

BOTTOM RIGHT: GETTY IMAGES

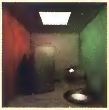
Future of 3D Graphics

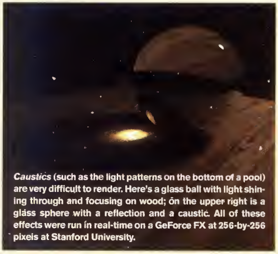
By: Nick Stam

IT'S HARD TO STAND OUT IN AN industry filled with scientists and mathematicians. Go ahead, give it a try. See? We told you so. Who can compete with Jim Blinn, Alvy Ray Smith, Kurt Akeley, and John Warnock? How about David Kirk, one of the brightest and most influential graphics architects in the world, and 2002's recipient of Siggraph's annual Computer Graphics Achievement Award? In fact, many of the world's leading graphics architects now work for Dave at nVidia. So when Kirk spoke recently about the future of graphics, people listened.

Creative Uses for GPU Power

We all know that most current 3D games barely take advantage of the programmable features of today's GPUs, and that once more games start using DX9 features, we should see a marked increase in visual quality and realism. Of course, the new programmable and powerful GPUs aren't limited to game usage. Many researchers are exploring graphics rendering methods that weren't possible with older GPUs. Kirk cited a lighting effect called *subsurface scattering*. The GPU simulates the process of light coming from behind, entering a surface and bouncing around, and then coming out in various directions, causing a glow effect. When light hits an object from behind, the object appears totally black when the scene is rendered using standard lighting methods; if it's made transparent, the result is a smeary image. Using subsurface scattering method—a computationally-intensive procedure—the light at each location is affected by the distance the light it has traveled. At the outer edges, a halo is generated, simulating some of the light wrapping around and scattering along the surface. Although such rendering cannot yet be run in real time with today's GPUs, Kirk estimates the day when it will is not far off.





***Caustics* (such as the light patterns on the bottom of a pool) are very difficult to render. Here's a glass ball with light shining through and focusing on wood; on the upper right is a glass sphere with a reflection and a caustic. All of these effects were run in real-time on a GeForce FX at 256-by-256 pixels at Stanford University.**

EXTREME CONTRIBUTOR: **Nick is co-founder of ExtremeTech. For 10 years prior, he was Technical Director (affectionately called "chief geek") of PC and hardware testing at PC Magazine Labs.**

University Graphics Research

What's cooking at the major university labs, where many new developments and technologies originate? The University of North Carolina is tackling an advanced form of ray-tracing called *photon tracing*, in which light rays are not only traced back from an object to determine where the light came from, but also forward from the light sources around the scene to see where focused light lands on particular objects. It's a very hard problem computationally, because most light emitted from a light source radiates in different directions or bounces around a scene without affecting the object you're looking at. Thermodynamic simulations and fluid flow are also areas that new, powerful GPUs can tackle. These areas benefit from today's GPU's new strengths.

UNC is working on wireframe radiosity simulations operating in real-time. According to Kirk, we're close to performing full-scene radiosity in real-time. Another important area is research into the generation of realistic shadows for complex models, such as power plants, ships, or factories. This opens up the potential of large walk-throughs of complex environments such as city streets or even virtual worlds, where lighting and shadows appear in a highly realistic manner. Caltech is focusing on tough physical simulation problems that aren't specifically graphics-related but rather process large amounts of sample data (as from a sensor). Much physically-sampled data is noisy and needs filtering, so Caltech used the power of GPUs to run brute-force filtering algorithms. The same techniques apply to graphics, where material and shape properties of real-world models could be obtained with sensors and then processed into accurate models. Caltech is also wrestling with unstable turbulent-fluid-flow and particle simulations. These are similar to large-scale weather simulations.

Kirk wrapped up by stating that it's the end of graphics as we know them. Many new things will soon be possible with large scale streaming processors, which will create a whole new revolution in graphics. And we'll see much more exciting graphics scenes based on realistic simulations of physical entities and processes.

NICK STAM BILL WYLIE

market, and it's substantially cheaper.

And the Winner Is...

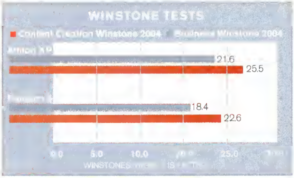
So, with $1,000 to spend, should you buy a Pentium 4 or Athlon XP for your do-it-yourself gaming PC? Going by the numbers, the advantage goes to the Athlon XP. At a similar price, you get equal or better game performance, and the faster video and audio encoding times are a nice benefit as well. But our $1,000 Pentium 4 system has two advantages: Hyper-Threading should keep performance up while multitasking, and the inexpensive Pentium 4 motherboards commonly have Serial ATA connections, which are rare on low-cost Athlon XP boards.

Despite the excellent overall performance of this new PC and its ability to run all modern and upcoming games pretty well, there is potential for improvement. Consider these prospective upgrades: For starters, the 128MB video card, while fast, may not have enough video memory to use all the textures in some upcoming games without spilling over into AGP system RAM. The main RAM could easily be upgraded to a gigabyte too. Though that won't affect performance in most games this year, the vast resources consumed by titles like EverQuest 2 may overflow 512MB pretty easily. Finally, the 80GB hard drive offers a good deal of space, but a pair of Serial ATA or even parallel ATA drives in a RAID stripe would deliver a lot more space and performance.

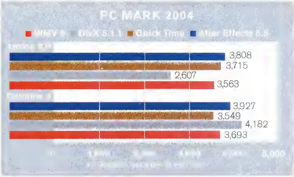
The bottom line is that you wouldn't be badly off with either an Athlon XP 3000+ or a Pentium 4 2.4C in your gaming PC. For major power, you would want a Pentium 4 at 3.0 GHz, or better yet, an Athlon 64. Perhaps the next time we build a $1,000 gaming PC one of these will be cheap enough to use. But prices are always dropping, so check before you buy. Happy fragging! **X**

SHOWDOWN: SPEED TEST RESULTS

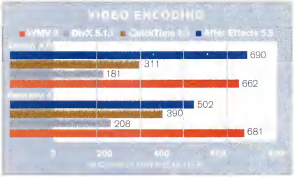
It's nice to have a picture of the overall system performance, but this is a gaming system we've built, and we want to know how well it plays games. So we ran a few general benchmark tests, and then opened up with a slew of games, including Halo, Splinter Cell, and Dungeon Siege. Let's take a look at how the two systems compare.



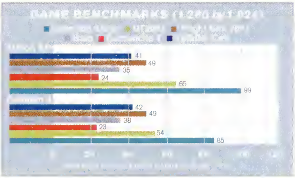
Winstone runs a variety of common applications to determine overall performance: business and productivity apps in Business Winstone and video, audio, and Web development in Content Creation Winstone. The Athlon wins, and we ain't surprised. Athlon chips have always performed well on these tests relative to their similarly priced Intel counterparts.



PCMark 2004 adds several multithreaded tests to the 2003 suite and now includes storage and graphics tests. While based on real-world apps, it's still quite a synthetic test, with many tests fitting inside the processor cache. CPU clock frequency and FSB speed play a bigger role, resulting in much better numbers for the P4.



For our **video encoding** tests, we compressed a high-bitrate AVI using various resolutions, encoders, and effects. Adobe AfterEffects batch-processed for us. AfterEffects doesn't like the Athlon XP nearly as much as the P4; our AMD rig ran these tests almost 40 percent slower. It whaled on video compression tests, though, particularly QuickTime.



game benchmarks: We ran all tests at 1,280-by-1,024, an aggressive resolution for such inexpensive PCs. But that's how you want to play games, right? And we turned image quality up wherever we could. The Athlon XP is a frame behind on a couple of games, but posted much higher scores on both Unreal Tournament 2003 and Dungeon Siege.

If this much ice actually forms on the outside of your computer, perhaps you should consider overclocking—just so your PC doesn't overheat.

START YOUR ENGINES

H 2 0

BUILD IT

LIQUID-COOLED PERFORMANCE PC

Liquid cooling can turn an overclocked, overheated machine into a stable, ice-cold beast. But do H_2O and CPUs mix? / Loyd Case

Don 't you hate playing IT support department for all your friends? The next time someone asks you how to upgrade a computer, suggest cleaning the old system out thoroughly before adding new parts. We usually recommend hosing a PC down completely, to get all the dust and dirt out as well as to get the parts shiny and clean. Of course, we say reassuringly, ordinary tap water will work fine. Got a sprayer attachment in the sink? Perfect. *Then* begin the upgrade.

There are other great uses for water too, of course. If the idea of having half a dozen case fans creating a small tornado in your office is less than appealing, you'll probably like the concept of liquid cooling. Too many of today's PCs sound like vacuum cleaners; liquid cooling offers a simple solution to all of those fans that's quiet and effective. In this story, we detail plans for Athlon- and Intel-based liquid-cooled PCs using off-the-shelf cases from Koolance. We're also entering the overclocking arena. We've never been fans of overclocking, due to the high degree of variability among components. In fact, we ran into some interesting issues based on our choice of storage components. At any rate, we compiled our standard set of benchmarks at the default clock rate, then pushed the system a bit and collected game benchmarks at the overclocked rate. Read on to find out what we did, how to do it yourself, and the pitfalls we fell into so you won't have to. Our component choices are based on our experiences running benchmarks, checking out new hardware, and building and rebuilding systems. Our primary emphasis is always stability first, then performance. After all, a speedy system that crashes often is no boon.

Case, Power Supply, and Cooling

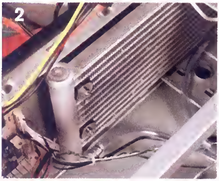
When looking around for a good liquid-cooling solution, we wanted something easy to use, proven, and well documented. This led us to Koolance, a well-known purveyor of liquid-cooling components and kits for a variety of PC hardware. Initially we opted just for a CPU cooler, though you can also cool the graphics hardware and possibly even the core logic.

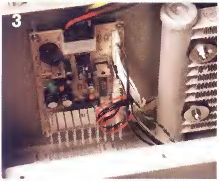
The power supply of choice was the reliable Antec TrueControl 550. It delivers rock-solid current and is well suited to powering the myriad components in our system. For our initial foray into water cooling, Koolance shipped us a black PC2-650BK. The case itself is sheet steel, with a pair of removable drive bays, lots of internal working space, and front-panel USB and FireWire ports.

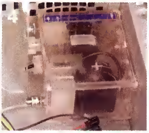
Koolance has grafted a liquid cooling system onto this very solid case design. The top of the case houses the control electronics plus the heat exchanger. Heat is removed from the PC and delivered to the heat exchanger via a mixture, carried in plastic tubes, that is made up of 70 percent deionized water and 30 percent ethylene glycol. Three fans on top of the case draw air across the heat exchanger. If you run the Koolance system at full throttle, it can get fairly loud. Unless you're trying to severely overclock your system, however,

GETTY IMAGES; OPPOSITE PAGE: CHRIS STEIN

MAKE THE CASE







BOTTOM RIGHT: CHRIS STEIN

you'll never hear the fans kick into high gear. Even under intense benchmarking and game play, the system was generally quieter than an equivalent PC in a similar but purely air-cooled case.

The fan housing at the top of the case also contains the display and control panel. The mode button lets you switch between three different modes, but we kept the system in mode one, which runs the Koolance system at 45 percent power until the temperature gets up to 45 degrees centigrade. But we never saw the temperature exceed 40 degrees, even when we increased the CPU's clock rate a bit. When you buy a Koolance system, you also need to get the proper heat sink. In our case, the correct choice was the CPU-300-H06 model, which is specifically designed for the PC2-650 system.

FREEZE OUT
Koolance lets you monitor the temperature and change options easily (Figure 1). Liquid passes through the exchanger (Figure 2) while air flows over it, much like a car radiator. A circuit (Figure 3), mounted next to the exchanger, controls the pump's action. The liquid itself is stored in a reservoir (Figure 4). It's actually mounted in the bottom of the case. For power, we installed an Antec TrueControl 550 (Figure 5). 550 watts of power, with a front control panel, too.

PROCESSOR, MAINBOARD, AND MEMORY

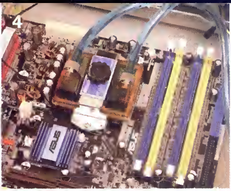
AMD: The Athlon FX-53 is a barn burner when it comes to 3D gaming performance. The integrated memory controller and overall efficiency of the architecture results in a CPU that generates smooth frame rates when coupled with a high-performance 3D accelerator.

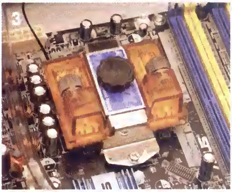
A speedy processor deserves a motherboard that minimizes bottlenecks. In the past, we've used the venerable Asus SK8N, which is built on the aging nForce3 Pro150 chipset. nVidia is busy readying a new chipset, but Socket 940 won't be supported. So we turned to Asus once again for the SK8V, which is based on VIA's K8T800 chipset. Its key feature is the modern VT8237 South Bridge, which offers a pair of integrated Serial ATA ports, Gigabit Ethernet (using 3Com's 3C940 PCI networking chip) and onboard FireWire.

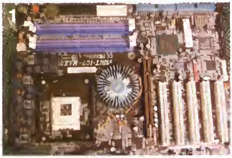
We tested several brands of memory modules, and discovered that Corsair XMS TwinX registered memory, TwinX 1024RE-3200LL, ran at the lowest latencies. More important, it seemed more stable when we pushed the front-side bus clock. Combining a pair of 512MB PC3200 sticks, this kit seemed rock-solid.

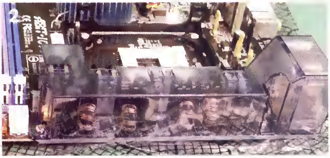
Intel: We were fairly sure that any Pentium 4 system wouldn't be quite as speedy at games as the Athlon 64. But a high-end P4 system can be more versatile, offering multitasking performance

MOTHERBOARD









CHILLIN'

The right motherboard makes all the difference. We used an Asus SK8N for our AMD system and an Abit IC7 Max3 (Figure 1) for Intel. The IC7 Max3 features a shroud over the power regulators (Figure 2), so they won't melt your cooling tubes. Take a look at the heat sink before we pumped it full of liquid (Figure 3). It attaches simply enough with screws to the fan bracket hardware. Then the tubes plug in, the liquid starts circulating (Figure 4), and the magic happens.

that's a bit better than AMD's due to Intel's Hyper-Threading technology. The P4 also tends to perform a bit better in media editing and encoding applications, though the FX-53 has narrowed the gap considerably.

But which Pentium 4 to choose? If we select Prescott, we get a CPU that underperforms in today's games and runs on the hot side to boot. If we go with a Northwood processor, we have a proven CPU that may be somewhat overclockable. And if we choose the Pentium 4 Extreme Edition, we get a big chunk of L3 cache but that cache may result in a CPU that can't be overclocked much.

High-end CPUs typically aren't very overclockable anyway, unless you get lucky. Our Athlon 64 FX-53 system barely sustained a 5 percent overclock while re-maining stable in all applications. So we tossed budgetary restraint to the wind and opted for the 3.4-GHz Pentium 4 Extreme Edition. You can actually buy one of these puppies, but it will set you back almost a grand. For that, you get a CPU built on Intel's 130-nm process, with 512K of L2 cache and 2MB of L3 cache.

A good processor demands a good motherboard. We wanted one built around Intel's speedy and reliable 875P core logic. We also wanted flexibility for tweaking. In the end, we settled on the Abit IC7 Max3. The Max3 is a bit over-the-top—it even offers special cooling for the power regulation section, which Abit dubs OTES (Outside Thermal Exhaust System). The OTES cooler basically draws air over the power regulator and exhausts it outside. Having the OTES shroud over the power-regulation circuitry makes routing the liquid coolant tubes easier. You no longer have any fear that the tubes will melt against a hot power circuit or bump against and dislodge a capacitor.

This motherboard offers a robust set of I/O options, even though the OTES exhaust fan consumes substantial real estate in the ATX I/O shield. Abit has sacrificed the parallel port and both RS-232 ports, but you get digital audio in and out, four USB 2.0 ports, a FireWire port, and a Gigabit Ethernet port. Finally, the IC7 Max3 has a plethora of storage options: two parallel ATA

Managing Memory

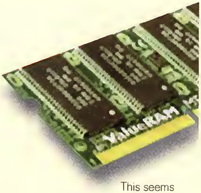
By: Loyd Case

For a time there, it looked as though Rambus might take over the world, and we'd all end up paying twice as much for memory chips as we do today. Close one! There have been quite a few recent advancements in RAM, however, that have boosted speeds and lowered power consumption. Read on for the details.

The Facts

Most new PC systems sold in the past year use DDR (that's double data rate) memory. DDR memory pumps out two data samples per clock cycle. You'll typically see it rated at the *effective* clock rate of the memory, as if it were sending one data sample per clock cycle. For example, DDR400 memory really runs at 200 MHz, but you'll often see it listed as "400-MHz effective."

An alternative naming scheme uses the effective speed of the memory. So DDR400, which is capable of shipping out 3.2GB of data per second, is also called PC3200, for 3,200MB per second (so *that's* where that came from).



EXTREME CONTRIBUTOR:
In 1988, Loyd figured out that building his own PC was vastly more interesting than buying off-the-shelf systems and he ditched his aging Compaq. The Sony 3.5-inch floppy drive from his first home-brew rig is still running today. And fortunately, he's finished digging out from that disaster.

This seems pretty fast, but by processor standards it's not. A 3.4-GHz Pentium 4 or a 2.4-GHz Athlon 64 FX-53 still spends a lot of time waiting for memory. That's one reason CPU cache sizes have been increasing: to reduce the time spent waiting for data to be retrieved from memory.

A few issues affect the stability and performance of DDR. Memory termination, for example, isn't built into DDR memory; it's actually a set of resistor packages on the motherboard itself. Termination minimizes signal reflections that would otherwise degrade stability. This adds some cost and increases instability as clock rates go higher, since the termination resistors are relatively far away from the DRAM chips. Another escalating problem is the heat and power draw created as memory clock rates go up. Problems, problems, problems!

DDR2: Lower Power, Higher Latencies

The latest memory for mainstream PCs is DDR2, which solves some of these problems. DDR2 has on-die termination, which improves signal integrity at higher clock rates. And it solves the power and heat problem in a clever way: The actual memory core clock half the clock rate "seen" by the system. DDR1, by contrast, clocks the core at the same speed as the external I/O clock. For example, DDR2/533 clocks at 266 MHz, but the internal core clock is 133 MHz. The I/O buffer clock is 266 MHz, and that's the clock rate that the system understands. To get around this seeming contradiction, DDR2 batches up four bits per clock cycle.

Since the I/O buffers run twice as fast, it really only hands off two bits per I/O clock cycle. So internally, the core is presenting data to the I/O buffers at quad data rate, but externally, the system sees two data items per clock cycle. In other words, DDR2 *prefetches* four data items per I/O clock cycle, while DDR1 only prefetches two.

DDR1 CAS latencies could be as low as 2 clock cycles, though typical modules are 2.5 or 3. The DDR write latency is 1 clock cycle, but as the external frequency goes up, that's too little time. So DDR2 adopts a simple algorithmic approach, where write latency is always CAS latency minus 1. So if CAS is 4 (typical for current modules), write latencies are 3 cycles. From the perspective of the system, the actual delay hasn't changed much. CAS2 for DDR-400 is roughly 15 ms, while CAS4 for DDR2/533 is about the same. Bandwidth goes up, though, because the relatively slow latency is for that first read of the memory row. After that, memory streams out to the system per the higher clock rate. Of course, if the system is running DDR2/400, you may see little or no performance gain.

DDR2 AT A GLANCE

Component Speed	Module Speed	Front Side Bus Speed	Data Rate	Module Bandwidth	Dual-Channel System Bandwidth
DDR2-400	PC2-3200	200 MHz	400 MT/s	3.2 GB/sec	6.4 GB/sec
DDR2-533	PC2-4300	266 MHz	533 MT/s	4.3 GB/sec	8.6 GB/sec
DDR2-667	PC2-5300	333 MHz	667 MT/s	5.3 GB/sec	10.6 GB/sec

Source: http://www.crucial.com/DDR2/

LOYD CASE LARA HATA

ports, the inevitable floppy connector, and no less than six SATA ports. True, four of them live on the PCI bus through the Silicon Image SiL 3114 controller, but having that many SATA ports is useful if you want to move away from parallel ATA completely. Finally, we opted for a pair of 512MB Kingston HyperX PC-4300 DDR memory sticks, for a total of 1GB of memory for our system. The high rating of this RAM should give us some headroom for experimentation.

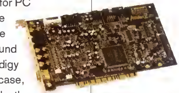
Graphics Hardware

No gaming system would be complete without a high-performance graphics card. We used an nVidia GeForce 6800 Ultra. We didn't want to dig into our board to replace the cooling fan with a Koolance liquid-cooling module, so we stuck with the built-in cooling fan. While it was much quieter than past nVidia efforts, it was still the noisiest part of the system.

Of course, a good graphics card deserves a good monitor. We actually configured a flat-panel LCD for a gaming system—our first ever. We used the Dell 2001FP, which offers 1,600-by-1,200 resolution, DVI and VGA input ports, and crisp, rich color rendition. The display also sports a 16-ms black-to-white response time, which is well suited for fast-action gaming. We've seen little or no ghosting when playing action games, both single- and multiplayer.

Audio Encoding

We wanted the best possible audio support for PC gaming, so we naturally chose a Creative Sound Blaster Audigy 2 ZS. In this case, we went with the Platinum model, which includes a 5.25-inch bay-mounted control panel. Of course, no audio system would be complete without speakers. We've been very happy with the Creative GigaWorks 7.1 THX speaker system. It's a tad forward in the mid-bass out of the box, but a few tweaks to the Audigy 2's equalizer clean things up nicely.



Storage

Fast, reliable hard drives are vital to any performance system. We wanted the performance of RAID Level 0, the convenience of Serial ATA, and the reliability of an enterprise-class hard drive. That left us with a single option, but it's a stellar one: the Western Digital WD740 Raptor 10,000-rpm SATA drive. We plugged a pair of these drives into the Via VT8237 South Bridge SATA ports and configured them as a striped RAID 0 array.

We had our pick of optical drives. In the past we've liked the Plextor PX-708A, but this time we decided to go upscale, opting for the new Sony DRU-700A dual-layer DVD burner. It's pricey and dual-layer media is still hard to come by, but it's the only game in town at this time if you want dual-layer drives. One last storage item we needed was the lowly floppy disk drive. Rather than settle for any old floppy drive, we used the Mitsumi FA402A combination floppy disk drive and 7-in-1 USB 2.0 memory card reader.

Installation

Installation was about as straightforward as it could get, given the complexity of the system. Much of the ease of installation is due to the superb documentation that Koolance ships with the system. You can even download a PDF version of the full documentation. A somewhat abbreviated version is also available online.

About the only time we had to puzzle things out a bit was when we mounted the Athlon 64 adapter for the Koolance heat sink. The default adapter doesn't work with the Athlon 64 or Xeon processors. As it turned out, all we had to do was remove the plastic heat sink bracket mounted on the motherboard. We then used the bracket-mounting hardware to attach the Koolance heat sink.

Once the heat sink is in place, you actually turn the case upside down to fill the coolant

ICE ICE BABY: COOL CALCULATOR

The nice thing about liquid cooling is the overhead the system affords you. Overclocking, while only giving you a little more performance, can sometimes mean the difference between winning or losing a fragfest. See the next page for all our benchmark results.

SPLINTER CELL

CPU	Clock rate	GPU	Splinter Cell (640-by-480)
Intel P4EE	3.4 GHz	nVidia GeForce 6800	77.02
Intel P4EE	3.56 GHz	nVidia GeForce 6800	80.62
Intel P4EE	3.56 GHz	ATI Radeon 9800XT	76.47
AMD A64 FX-53	2.4 GHz	nVidia GeForce 6800	91.66
AMD A64 FX-53	2.53 GHz	nVidia GeForce 6800	93.33
AMD A64 FX-53	2.4 GHz	ATI Radeon 9800XT	88.66

For reference purposes, we also built this system using an Asus P4C800-E Deluxe motherboard—essentially a similar configuration

Intel P4EE	3.4 GHz	ATI Radeon 9800XT	7702

MULTITASKING

CPU	Clock rate	GPU	Test 1	Test 2
Intel P4EE	3.56 GHz	nVidia GeForce 6800	28.39	30.33
Intel P4EE	3.4 GHz	nVidia GeForce 6800	29.21	29.7
Intel P4EE	3.4 GHz	ATI Radeon 9800XT	28.19	30.56
AMD A64 FX-53	2.53 GHz	nVidia GeForce 6800	28.19	30.56
AMD A64 FX-53	2.4 GHz	nVidia GeForce 6800	22.98	21.13
AMD A64 FX-53	2.4 GHz	ATI Radeon 9800XT	22.46	20.55

Task 1 shows simultaneous file compression and encryption; task 2 is decompression and image processing.

Kings of Cool

Our benchmark test suite covers a wide range of applications that are significantly affected by CPU performance. The suite consists of a mix of synthetic and actual applications, but is heavily weighted towards real applications.

In theory, the P4's use of simultaneous multi-threading should give it an edge in multitasking performance. On these synthetic tests, Intel does outpace AMD. The big L3 cache in the Pentium 4 Extreme Edition, combined with Intel's Hyper-Threading technology, makes for more efficient multitasking under certain scenarios.

As you can see from the software 3D rendering tests, the P4EE can perform quite well against the competition, given the right application mix. But that mix of applications doesn't extend to gaming. That's not to say that the P4EE is a poor gaming platform: It performs pretty darned well. But the Athlon 64 FX-53 is simply in another class entirely when it comes to running games.

All of our game testing was per-formed on "clean" systems, with no substantial background tasks running. If you're like us, though, you probably have a fairly busy system tray. It's difficult to quantify, but the Pentium 4 running games in an environment that includes busy background tasks could eat into AMD's lead. These tests don't always yield interesting results, so we've skipped all the boring stuff.

▶ **The bottom line:** As a standalone gaming system, our liquid-cooled Pentium 4 Extreme Edition rig certainly performs well but simply can't keep up with the Athlon 64 FX-53 system. But if you can't dedicate a system to gaming, the P4 may be a viable choice. Whether that's worth $350 more is between you and your wallet.

3D Modeling, Content Creation

▶ The Pentium 4 really shines here, as it performs very well versus the Athlon 64 on various software rendering tests.

3DMark 2003

▶ We ran 3DMark 2003 normally at 640-by-480 and with software vertex shaders at 640-by-480. The Pentium 4 had a slight edge against the AMD here, while the Athlon 64 posted noticeably higher scores on the 3DMark 2003 CPU tests.

3D Games

▶ It's not much of a contest here. While the P4EE is no slouch as a gaming CPU, it was simply outclassed by the Athlon 64 FX-53 on all but one of the game tests. We tested at high resolution, but without anti-aliasing or anisotropic filtering.

[illegible]

CPU	Clock rate	GPU	software vertex shaders	hardware vertex shaders	CPU Test 1	CPU Test 2
Intel P4EE	3.4 GHz	nVidia GeForce 6800	3,292	17,510	[illegible]	16.7
Intel P4EE	3.56 GHz	nVidia GeForce 6800	3,592	17,717	[illegible]	17.2
Intel P4EE	3.4 GHz	ATI Radeon 9800XT	2,844	9,754	[illegible]	14
Intel P4EE*	3.4GHz	ATI Radeon 9800XT	2,664	9,774	[illegible]	12.9
AMD A64 FX-53	2.4 GHz	nVidia GeForce 6800	3,556	17,046	[illegible]	17.4
AMD A64 FX-53	2.53 GHz	nVidia GeForce 6800	3,660	17,149	[illegible]	17.7
AMD A64 FX-53	2.4 GHz	ATI Radeon 9800XT	2,869	9,770	[illegible]	13.5

* For reference purposes, we also built this system using an Asus P4C800-E Deluxe motherboard—essentially a similar configuration.

The latest version of 3D Mark 2003 has had its share of controversy. It's still useful for gauging how a CPU might fare with real-time 3D applications. These synthetic tests reveal the behavior of key subsystems.

3D MODELING, CONTENT CREATION

CPU	Clock rate	GPU	Lightwave 7.5 Tracer2	3D Studio Max SinglePipe2	3D Studio Max Underwater
Intel P4EE	3.4 GHz	nVidia GeForce 6800	886	961	1,288
Intel P4EE*	3.4 GHz	ATi Radeon 9800XT	889	958	1,273
AMD A64 FX-53	2.4 GHz	nVidia GeForce 6800	893	1,057	1,450

* For reference purposes, we also built this system using an Asus P4C800-E Deluxe motherboard -- essentially a similar configuration.

3D Studio Max, LightWave, and Cinebench 4D are professional modeling and animation tools. Here we test rendering performance, enabling multithreading where needed (3D Studio Max is multithreaded by default).

GAME PERFORMANCE

CPU	Clock rate	GPU	Dungeon Siege (1,280x1,024)	Unreal Tournament 2003 (1,280x1,024)	Halo (1,024x768)	Flight Sim 2004 (1,280x1,024)	Splinter Cell (1,280x1,024)	[illegible]	Serious Sam SE (1,280x960)
Intel P4EE	3.4 GHz	nVidia GeForce 6800	129.89	71.51	98.54	81.85	77.02	[illegible]	167.8
Intel P4EE	3.56 GHz	nVidia GeForce 6800	135.91	75	101.1	85.84	80.62	[illegible]	181.9
Intel P4EE	3.56 GHz	ATI Radeon 9800XT	121.59	72.29	93.59	84.33	76.47	[illegible]	161.6
Intel P4EE*	3.4 GHz	ATI Radeon 9800XT	128.58	72.78	90.34	81.35	77.02	[illegible]	163.8
AMD A64 FX-53	2.4 GHz	nVidia GeForce 6800	158.24	88.67	102.95	108.26	91.66	[illegible]	196.7
AMD A64 FX-53	2.53 GHz	nVidia GeForce 6800	165.75	90.52	106.59	108.36	93.33	[illegible]	200.8
AMD A64 FX-53	2.4 GHz	ATI Radeon 9800XT	141.89	88.17	96.19	105.64	88.66	[illegible]	181

* For reference purposes, we also built this system using an Asus P4C800-E Deluxe motherboard—essentially a similar configuration

Our 3D game tests offer a mix of CPU-intensive and memory-hungry tests. We depart from past test reporting by providing only high-resolution results. After all, this is a gaming system; we want to see how frame rates fare at playable resolutions.

reservoir, using a supplied funnel. The coolant tank and pump assembly are mounted in the bottom of the case.

You prime the pump by running it without actually powering up the whole system. After the priming phase, you're good to go. The coolant has a lifetime of about a year, whereupon you'll need to drain the old coolant and replace it. The manual contains all the instructions needed for this process. Overall, we'd have to give the Koolance system a big thumbs-up for its ease of installation and quiet, efficient operation. And amazingly, it's only about $270 as configured.

UNLESS YOU'RE TRYING TO SEVERELY OVERCLOCK YOUR SYSTEM, YOU'LL PROBABLY NEVER HEAR THE FANS KICK INTO HIGH GEAR.

Benchmarking and Overclocking

AMD: The SK8V motherboard's overclocking options are somewhat limited. You can set the front-side bus clock for the FX-53, but the memory clock can't be set beyond 200 MHz (that's 400 MHz in DDR-speak). We did experiment with FSB clocks up to 220 MHz (the default is 200 MHz). The FX-53 uses a 12X clock multiplier, which results in a default clock speed of 2.4 GHz. A 220-MHz FSB yielded 2.64 GHz. But the system really wasn't stable at that speed. We got frequent crashes that indicated some type of memory issue, though they could have been caused by the integrated memory controller rather than the Corsair memory itself, which never ran faster than 200 MHz.

At 215-MHz FSB (which left us with a 2.58-GHz CPU), the CPU and memory seemed to run just fine, but we would occasionally get some disk corruption on the RAID 0 array. We're not quite sure what was going on, since the VT8237 South Bridge was running at the default clock. It wasn't until we reduced the FSB clock to 210 MHz (2.53 GHz) that we were rock-solid. We ran a series of benchmarks at this speed without any issues at all. A CPU speed boost of 130 MHz is nothing to sneeze at, but as you'll see in our benchmark results, games didn't realize much faster performance from overclocking.

On top of that, the Koolance system never hit 40° C during the entire time we spent benchmarking performance. One final note: To achieve any stability at all, we had to tweak the CPU voltage up 150 mV, from the default nominal 1.50V to 1.65V. This may shorten the lifetime of the processor, and that's a pretty serious consideration for a $770 CPU.

Intel: One of the nifty features of the IC7G Max3 motherboard is its capability to lock the AGP and PCI clocks. So we fixed them in the BIOS to 66 MHz and 33 MHz, respectively. Then we increased the front-side bus clock until the system became unstable running PCMark 2004.

We suspected that the P4 Extreme Edition might not be a robust chip for overclocking, at least on a percentage basis. After all, it's already running at 3.4 GHz! As it turned out, our assumption was correct: We topped out at an increase of 4.5 percent—a 9-MHz increase in the FSB clock. We chose to run the memory clock in sync with the CPU rather than at a lower clock, because added memory bandwidth is also useful, especially for games. So our system topped out at a 209-MHz FSB clock, for an effective DDR clock of 418 MHz and a processor speed of 3.56 GHz. As with the Athlon, an extra 160 MHz sounds good, but we didn't see a dramatic improvement in gaming.

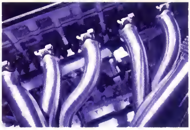
XTIPS

- **Koolance is switching to** polyeurothane tubes, for their increased flexibility and ability to remain clear after months of use. If your tubes seem old and dirty, you can buy new PU tubes from Koolance.com.
- **Don't drink the Kool Aid.** And don't drink the fluid either. The liquid in those tubes is a mixture of deionized water and ethylene glycol, a colorless, syrupy liquid used to make antifreeze and deicing solutions. While generally harmless, large amounts can cause serious health problems.

Final Thoughts

After building our liquid-cooled rigs, we're pretty enthusiastic about the concept. But it's by no means perfect. For one thing, it does add some internal clutter to a system, which is already full of cables, wires, and brackets. Second, a Koolance system does require annual maintenance. While you might be able to get away with a couple of extra months, it's a good idea to drain and replenish the coolant on schedule. And despite our positive experience, we're still just a little bit nervous about having liquid coursing through the innards of a high-performance PC. But we can say unequivocally that the technology works, and works well. **X**

YOUR FRIENDS AND NEIGHBORS will be wicked jealous when the see what you've been building. Quiet yet powerful (sort of like a ninja, right?), micro-ATX computers are poised to take over the DIY world.



BUILD IT

MICRO-ATX BLUEPRINTS

About the size of a toaster, these tiny PCs are powerhouses! But that doesn't mean you can throw out your oven. / Loyd Case

Usually women are the ones to intone the mantra about good things coming in small packages. Usually men pray that their references are to jewelry and not our virility. But lately the men of ExtremeTech have been thinking small as well. After all, Apple shrank the iPod, those Mini Coopers are selling like crazy, and small-form-factor PCs are all the rage. But too often the mini-marvels make you choose between cube-shaped PCs with limited expandability or pizza-box desktops with narrow flexibility and limited performance. We're not satisfied with either option. We love the dinky powerhouses. (That sounds so dirty, doesn't it?) We just want a little more.

To solve this problem, we decided to build a compact yet flexible system using a micro-ATX motherboard. Although typical mATX motherboards have one AGP and three PCI slots, most cases offer limited room. For example, you're often limited to low-profile AGP cards. Suffice it to say that "high performance" and "low profile" are not synonymous.

GENTLEMEN, EQUIP YOURSELVES

We went hunting for the right components to build a killer small PC. Our criteria were simple: We wanted to use bulkier PCI and AGP cards, particularly high-performance AGP graphics accelerators. We wanted sufficient power to keep the system running stable, even with a fast CPU and graphics card. And of course, with all that horsepower under the hood the machine had to stay cool.

Case and Power Supply

We generally like cube-shaped PCs like the Shuttle XPC line. But with only one PCI slot and one AGP slot, expansion is too limited. We like the Monarch Hornet,

Tech Toolbox

Bill of Sale

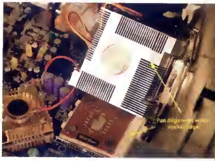
Case	Wavesonic/Enermax CS-3107-S	$60
Power Supply	AG 320W mATX	$30
RAM	1GB Kingston HyperX PC3200 DDR	$330
Optical Drive	Samsung SM-352	$49
Floppy Drive	Mitsumi FA402A	$29
Sound Card	Creative Labs Audigy 2 ZS Gamer	$130
DS	Microsoft Windows XP Pro	$135
Total		**$763**

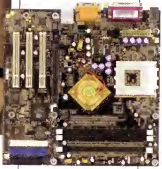
	AMD System		**Intel System**	
Processor	Athlon XP 3000+	$155	3.0-GHz Pentium 4	$190
Motherboard	Chaintech 7NIL1	$63	Intel D865GLC	$90
Graphics	eVGA 5700 Ultra	$173	ATI Radeon 9800 Pro	$202
Hard Drive	Maxtor DiamondMax 9 200GB	$155	Seagate 7200.7 160GB SATA	$120
Total		**$1,296**		**$1,352**

All prices are estimates before tax and shipping based on our price-comparison engine, *extremetech shopping.com*

GETTY IMAGES OPPOSITE PAGE CHRIS STEIN

SAYING THAT INSTALLING AN mATX MOTHERBOARD IS TRICKY IS LIKE SAYING THAT WATER AND POWER SUPPLIES DON'T MIX. DON'T LET THAT STOP YOU.





too, which expands on the cube concept by supporting mATX motherboards. But it has a bulky footprint—even bigger than a standard tower case. Fortunately, a new generation of mATX chassis is emerging, products like the Athenatech A106 and Wavesonic CS-3107-S. We stumbled across the Wavesonic case at a local shop recently and liked what we saw.

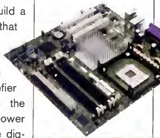
The CS-3107-S's aluminum case lets it radiate heat better than a steel chassis, and it ships with a couple of additional 6-cm exhaust fans in the rear. But the case has only a 230W power supply. We wanted to build a pretty substantial system that would be suitable for 3D games and other high-performance applications, so we needed something beefier that would still fit into the Wavesonic's mini-ATX power supply shape. After some digging, we found a 320W power supply made by AG, available at Directron and other outlets. But these things sell like hotcakes, so they may be out of stock in your area.

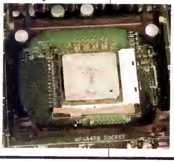
CPU, Mobo, Memory

Rather than simply selecting a CPU, we tested both Athlon XP and Pentium 4 motherboards. We didn't have time to include an Athlon 64 (it's a whole different beast, and this is just an mATX project, after all), but we know of two Socket 754 mATX motherboards: the Aopen MK89-L (based on the nForce3 150 chipset) and the Gigabyte GA-K8VT800M (which uses the VIA K8T800 chipset). Even for older CPUs, mATX motherboards are pretty limited. In the end, we chose the Chaintech 7NIL1 for the Athlon XP motherboard. This board, and its AC97-only cousin, the 7NIL2, are the only Socket 462 mATX boards we could find that used the nForce2 Ultra 400 chipset.

ATHLON DECATHALON **Do it wrong and you'll run in circles trying to troubleshoot! Align the ridge on the CPU socket with the depression in the heat sink.**

LARGE AND IN CHARGE **The fan bracket seems to take up even more real estate in a micro-ATX case, where space is already tight. When you're working in one of these cases, be extra careful not to knock off a capacitor.**





The Pentium 4 board was easier to choose. Though we would have loved to use a board based on the 875P chipset, none currently exists. There are numerous mATX Pentium 4 boards using Via and Intel 865 variants, but we settled on the Intel D865GLC or, as we call it, "old reliable." Our backup board is the Asus P4P800-VM, but we've been using the Intel board in other systems for some time now and have been fairly happy with it. Both the Intel and Asus boards use the Intel 865G chipset. You can even overclock the D865GLC... sort of.

Because we wanted these to be mainstream boards, we went ahead and used a pair of reliable Kingston HyperX DDR400 modules. We dropped in two 512MB sticks, for a total of 1GB in the system. The CPU cooling solutions were very similar: Vantec AeroFlow tip magnetic drive fans, which are actually pretty quiet, even when they rev up to 5,000 rpm.

We initially aimed high with our CPU choices, going for a 3.2-GHz Pentium 4 and an Athlon XP 3200+. These proved too ambitious, so we ended up settling for an Athlon XP 3000+ and a 3.0-GHz Pentium 4 (Northwood). The system ran too hot when the Athlon 3200+ and 3.2-GHz Pentium 4 were combined with high-performance graphics.

Graphics and Audio

One of our goals was to make this rig a serious gaming system. So we wanted to use the best possible graphics card, given our constraints. Initially, we looked at the Gainward FX Ultra/1800 XP, which has twin cooling fans, complete with spinning blue LEDs. The Gainward card, like a few other recent 5900 Ultra releases, can fit in a single AGP slot. Given its high cooling requirement, though, it's still best to leave the adjacent PCI slot free. This card was too much, however.

We ran 3DMark 2003 in looping mode to check out stability under stress. In the Athlon XP system, 3DMark never completed its first pass. It would either lock up hard, or we'd get a lovely screen of cascading colors, indicating overheating. The Pentium 4 system would actually run 3DMark for about 20 minutes, then hit our thermal threshold or lock up in the middle of a loop.

Given that, we realized that a Radeon 9800XT would run into similar problems. So we scaled back and popped in a 128MB Radeon 9800 Pro (though a 128MB nVidia 5900XT would probably have worked just as well). Again, the Athlon XP locked up without completing a single 3DMark pass. It wasn't until we installed an eVGA GeForce FX 5700 Ultra card that the system proved stable. The P4 system ran like a champ with the Radeon 9800 Pro. Both systems have similar thermal output for the CPUs, but the Intel motherboard's layout afforded greater airflow throughout the system.

Since we had three free PCI slots, we used one for a Creative Audigy 2 ZS Gamer. This card enabled us to offload a substantial amount of the 3D audio work from the CPU, which has a positive effect on frame rates.

Mass Storage

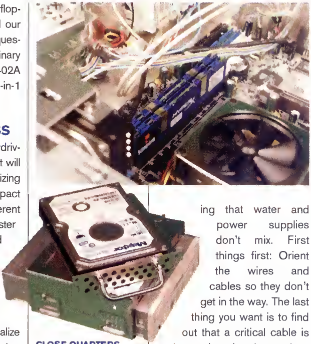
The Chaintech motherboard only supports parallel ATA, so we dropped in a Maxtor Diamond Plus 9 200GB hard drive, which spins at 7,200 rpm. We equipped the Pentium 4 board with a Seagate 7200.7 160GB SATA drive. This is a quiet but still fairly speedy 7,200-rpm drive. Since Serial ATA drives use more compact cables, routing them is substantially easier in tight quarters.

Due to the cramped quarters, optical storage was a challenge. We scoured our collection of optical drives and ended up using a Samsung SM-352 DVD-ROM/CD-RW combo drive. The primary reason was size: The Samsung drive is nearly an inch shorter than most other drives. Finally, there's the floppy drive. Why use a floppy, you ask? We scratched our heads and asked the same question. So instead of your ordinary drive, we used a Mitsumi FA402A combo floppy drive and 7-in-1 memory card reader.

ASSEMBLY PROCESS

Before you dive in with screwdriver in hand, a little forethought will go a long way toward minimizing heartache. Building a compact system is qualitatively different from building a full tower monster PC. It requires planning and finesse. Sometimes it's impossible to install a heat sink or memory after the motherboard is in. And don't forget to attach the HSF power wire. If you realize after the system is assembled that the heat sink power connector isn't connected, you may have to completely disassemble your PC to connect it. Otherwise, the first few steps are standard: Plug your CPU in, spread a small amount (a really small amount) of heat transfer paste across the top of the CPU and a very thin layer on the heat sink itself, and clip the heat sink in place.

All the mATX motherboards we came across use unbuffered SDRAM, which has a single, asymmetric key notch. Just pull back on the locking tabs, then align the key notch with the matching ridge in the memory socket and press straight down. It's easiest to attach storage device cables before installing the motherboard. Once the board is in, the space inside an mATX case is very tight. Also, it may be impossible to reach the connector locations once the board is in.



CLOSE QUARTERS
You conveniently install the main drives in this chassis via removable bays. This provides a very easy way to pull bulky drives out of the case–necessary, because as you can see, things can get mighty cramped in there.

Installing the Motherboard

Oh boy. Saying that installing an mATX board is tricky is like saying that water and power supplies don't mix. First things first: Orient the wires and cables so they don't get in the way. The last thing you want is to find out that a critical cable is jammed under the motherboard after you've screwed it down. A little masking tape goes a long way toward clearing up the wire jungle.

Check the mount points inside the case and be sure that all are in place. Next, insert the I/O shield—the thin, metal shield with cutouts for the keyboard, mouse, USB, and other I/O ports. If you're looking at the back, the holes for the keyboard and mouse are normally on the left. Once the I/O shield is in place, you can slide the board in. The space in a micro-ATX case is usually very tight. You should ensure that no small children are around before attempting this; the odds of an explosion of profanity will increase sharply.

Once the motherboard is in place and fastened down with screws, start attaching cables. The first thing to do is attach the front-panel switches, including the power and reset switches. You'll probably want to attach the front USB connector too. Normally these come as a loose conglom-

PCI Express for Laptops

By: Dave Salvator

If PC engineering is tough, then laptop engineering is excruciating. Designers have to stuff two high-performance processors—a CPU and a GPU—into a highly confined space where heat output and power draw have nonnegotiable limits. As new processors come to market, they present new challenges for laptops, and engineers wind up reinventing the wheel each time, creating new GPU modules to fit into different chassis. With the coming of PCI Express, however, the graphics people at nVidia and ATI are trying to make laptops more like desktops. By using a single form factor and pin-out, GPU makers and PC manufacturers can spend less time solving problems redundantly and more time inventing genuinely innovative laptop designs.

EXTREME CONTRIBUTOR: **Dave came to have his incurable tech jones by way of music, and because his parents wouldn't let him run away and join the circus. After a brief, ill-fated career in pro wrestling, Dave now covers audio, 3D graphics, and gaming technologies for ExtremeTech.**

LARA HATA

nVidia's Solution

nVidia launched the first missile with its Mobile PCI Express Module, or MXM. This spec is designed to accommodate all mobile designs, ranging from an integrated graphics pass-through to top-end mobile GPUs. nVidia has created a three-tier design, depending on the level of graphics performance needed. The fundamental difference between the three tiers is the physical size of the module; the pin-out is identical for all three. So if a chassis can accommodate the larger size and greater power/thermal requirements, a laptop that originally shipped with an MXM-I module can be upgraded to an MXM-II or MXM-III.

The MXM connector supports several display signals that should cover the various monitors a laptop might be connected to. The only one missing is HDMI (High-Definition Media Interface), a DVI-compliant connector that incorporates High-Definition Content Protection (HDCP), soon to be a standard feature on HDTVs. HDMI is supposedly backward-compatible with DVI, which is supported. Still, given that laptops have a service life of at least two years, nVidia would do well to add HDMI output to the mix. We certainly like the concept of MXM. It's been a long time coming in the laptop world, and it's a significant step towards the laptop-as-desktop-replacement paradigm. It could also bring us one step closer to building our own laptops and being able to cherry-pick the best components.

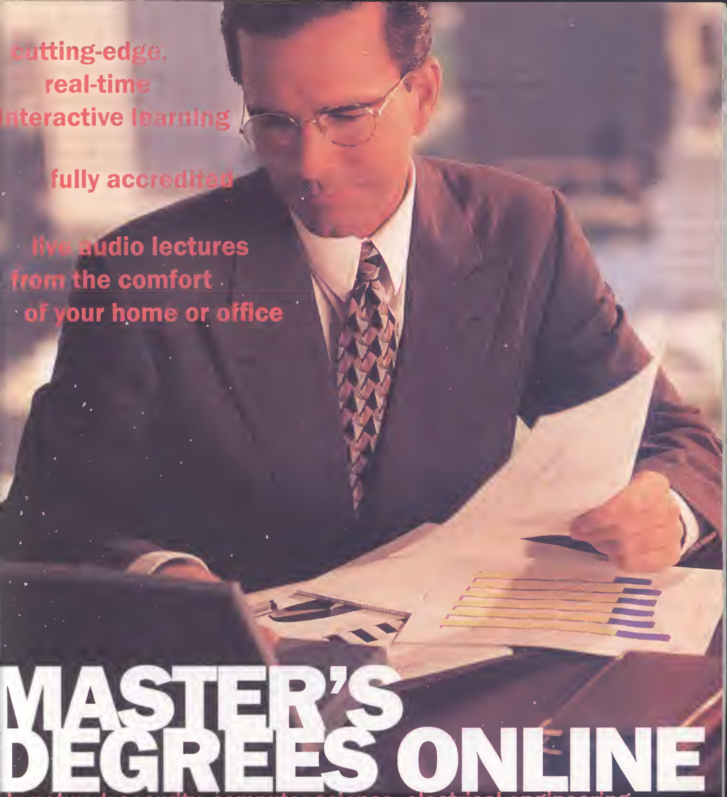
ATI's Response

Because this spec came from nVidia and not Intel, the chances of ATI saying "Great idea" were slim to none—and slim left town. While favorable to the overall concept, ATI found considerable fault with nVidia's approach. We spoke with Darren McPhee, marketing manager of mobile products for ATI, who claimed that "by offering the same module design to every customer, it forces them to design around the module, rather than start with the total design concept and go from there. The end result is that the vendor loses some of the competitive advantage it may receive through innovative system design." Long story short: ATI isn't signing on.

Instead, the company recently announced its Advanced eXpress I/O Module (AXIOM) specification as a competitive counterweight to nVidia's MXM. AXIOM is an outgrowth of the company's FlexFit spec, which it's been using with OEM customers for some time now. ATI notes that this specification delivers design flexibility, a robust and proven connector, and space savings, since the connector is optimized for smallest printed circuit board size and z-height, and designers can use the space underneath the module. It's also designed to take full advantage of the PCI Express interface: AXIOM is a full family of modules, not just graphics. We find this most intriguing, since it seems to tip ATI's hand in the area of bringing TV-tuner modules to laptop systems via AXIOM. Add that to the recent arrival of the HDTV Wonder and you're looking at a laptop with an off-the-air HDTV PVR built in—a very interesting twist in the crowded laptop market.

Not-So-Final Thoughts

Because the announcements were all paper and no silicon, we can say at this point only that these strategies seem essentially sound. But until we have all the hardware needed to test them—and the boards from both companies—our take is one of guarded optimism. We don't anticipate much performance difference between 8X AGP and PCI Express systems, since applications have been written primarily to work on 8X AGP. Regardless of which spec triumphs, PCI Express is the wave of the future—so be sure to stay tuned.



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eration of wires. Check your motherboard manual for the correct order. You can install any set of connectors to any internal USB pin-out, so long as the same numbers are installed on the same set of pins.

Finally, attach the power cables. Some motherboards, including all Pentium 4 boards, require two power connectors. First attach the standard, 20-pin ATX power connector; then connect the four-pin ATX12V plug.

Installing Storage Devices

The Wavesonic case has ample capacity for storage. You can add an optical drive, two hard drives, and a floppy drive, if you so desire. We opted for a combo floppy/USB 2.0 memory card reader and a CD-RW/DVD-ROM drive, in addition to our hard drive.

First, remove the front panel of the case. You'll find a latch on the bottom of the front panel—a large lever you press into the body of the case. Press it and pull the bottom firmly outward to detach the front panel. (But don't pull too far, or you'll yank out the front panel cables.) The optical drive bay is attached with a pair of Phillips screws, while the hard drive bay uses thumbscrews. The hard drive bay pulls out with a convenient handle; the optical bay is latched into the case. Press the latch towards the body of the drive bay and slide the back of the case up and out. The floppy is mounted into the case body, and it requires brackets (that do ship with the case) for proper installation.

The actual physical installation is pretty easy, but the order of events is the tricky part. Here's how you do it: First, attach the supplied mounting brackets to the floppy, then install the floppy in the case. Now attach the floppy cable and the floppy power cable. Next, install the hard drive by sliding the bay into the slot un-derneath the floppy drive. Be careful not to dislodge the floppy's power cable or its data cable. Attach the hard drive power and data cables. Using the thumbscrews, lock the hard drive bay into place.

Important: Clear out any wires or cables that may obstruct the top of the heat sink fan. Attach the power and data cables to the optical drive, and slide it into place by angling the front of the bay down, then sliding along the guide until the latch locks. Using the two Phillips screws, attach the bay to the case. Check again to make sure no cables are obstructing vital airflow over the top of the heat sink. Now the storage components are installed. Let's install the expansion cards.

Installing the AGP and PCI cards

We're installing a high-performance AGP graphics card and a Sound Blaster Audigy 2 ZS Gamer—actually a pretty easy task, at this point. The only tricky part comes if you're installing a bulky graphics card, like some of the double-wide nVidia cards. Interestingly enough, it's not the width but the backside heat sinks that can get in the way.

A long card may be a bit of a chore to install, though, because you'll need to maneuver some cables out of the way. Be careful during this step. It's very easy to actually break off a motherboard capacitor by accident. Just a little too much pressure as you're shifting around an IDE cable and you'll have a dead motherboard. One last thing you might want to do is dress the cables with some ties. Tiebacks, that is, not neckties. Carefully corralling the cables will improve airflow and thermal dissipation. It will also keep a stray wire from slipping into a fan and wreaking havoc.

At this point, you're ready to rock. Boot the system (cross your fingers first) and enter the BIOS setup screen. You'll want to take a quick look at the system health screen to ensure that the motherboard and CPU temperatures are reasonably constant and well below 50 degrees Celsius. After this, you'll want to disable the on-board audio (since a Creative Audigy 2 ZS is installed in a free PCI slot). Adjust your AGP aperture to 128 or 256MB and set your PCI latency timer to 64. Check to see if the storage devices are properly enumerated. You should see the hard drive and optical drive present. You'll want to set the first boot device to be the optical drive, so you can boot off the OS install disk. Now you can reboot with the OS CD in the drive and proceed to install the OS. Nice work! **X**

SAVOR THE MOMENT
Take a little time before sealing the case up to appreciate your handywork. This allows you a few minutes to pat yourself on the back, and it gives your PC time to warm up. Check the BIOS to ensure that temperatures are constant and well below 50 degrees Celsius; it's only going to heat up further when you button it up.

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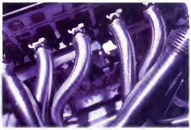
Here's the editor's set up, just to whet your appetite. The Apex TV is no flat panel, but then again, it was only a few hundred, not a few grand. Regardless, it's the ease of use that matters most, and here's where our PVR shines: Its simplicity belies its power.

START YOUR ENGINES



BUILD IT

P V R

EXTREME PERSONAL VIDEO RECORDER

When an ordinary TiVO just won't pass muster, consider our plans for the ExtremeTech version.

/ Dave Salvator

The living room PC: the Promised Land of computing, where our entertainment centers are intelligent and PCs are incredibly easy to use. Yeah, right. Though we're not there yet, we're getting ever closer to the day when every family member (not just the house sysadmin—that's you, in case you missed it) can fire up the PC media appliance, access stored music, video, and photos, and record television off the air, from cable, or from Webcasts. Soon we'll be able to see this device as just another component in the rack. Here's the challenge: It has to be versatile, powerful, and fast, yet stupid-simple to use. If you're the only one playing around with this appliance, go ahead and make it as byzantine as you want. If you want to let other family members watch TV too, it must be remote-control, just like a DVD player. It has to be conversant in multiple media types. The interface has to be easy to use and readable on a TV. And everyone in the family must be able to use it without a six-week training course.

We take the guesswork out. With this rig, you can watch DVDs, watch and record TV, rip and store audio, capture and store home video, create your own DVDs, and serve all that media up to the rest of your home network. You can also surf the Web, run PC games, and do just about anything else...

Case/Power Supply The Antec Sonata's combination of a 380-watt power supply, a sleek design, and lower overall noise output makes this case a very good candidate for our Extreme PVR system. Couple this case with a Zalman ducted CPU fan and you'll keep overall fan noise to a minimum. In this enclosure, the drive bays face the side of the case, and drives are mounted on trays with screws. The trays have attached rails, which then slide into the bays. The trays themselves have rubber grommets at the contact points, to minimize vibration transfer from drives.

Motherboard We went with an Intel 865PERL motherboard, which uses the Springdale chipset. This chipset is nearly identical to Intel's flagship DDR chipset, the 875, right down to support for Serial ATA and dual-channel memory. The primary differences lie in Intel's Performance Acceleration Technology (PAT for short), and the 875's support of ECC memory. PAT optimizes memory accesses on the front-side bus for lower latencies, and therefore more performance. The 865PERL has been rock-solid since the first day we fired it up

Tech Toolbox

Bill of Sale

Case	Antec Sonata	Quiet case with 380-Watt power supply	$130
Motherboard	Intel 865PERL	All the fixin's including dual-channel DDR and FireWire	$135
CPU	Intel Pentium 4 2.8GHz	800-MHZ FSB	$331
Graphics Card	ATI All-in-Wonder Radeon 9800	graphics card with TV-out capability	$450
Memory	512MB Corsair 400MHz DDR		$120
Hard Drive	Western Digital WD2000JB	200GB, 7200-RPM drive with an 8MB buffer	$225
Sound Card	Sound Blaster Audigy 2	DVD-Audio, 6.1 output, and solid gaming audio	$110
DVD Drive	Philips DVDRW 228	Combo DVD+/- RW, CD-RW 12X10X32	$100
Keyboard and mouse	Gyration Ultra Cordless	25-ft range, RF	$95
OS	Windows XP Home	Don't need Pro's extras here	$100
TiVO App	Snapstream Beyond TV 3	The most polished app currently available, with a very usable 10-foot UI	$60
DVD Player	CyberLink PowerDVD 5.0 XP Deluxe	DTS support	$70
TOTAL:			$1,926

GETTY IMAGES OPPOSITE PAGE CHRIS STEIN

Audio Codecs

By: Jason Cross

Millions of people digitize their CD collections without giving half a thought to the format. Why? Most people are chumps. They pick an application they like and use whatever the default settings are. You and I know better. We want the best-sounding audio, the smallest files, and complete compatibility with our portable players. But which format to choose? Compatibility is crucial, of course. We all have different audio devices, and it doesn't matter how good your music sounds if it won't play on your hardware. Encoding time is another consideration, but honestly, modern computers encode audio so quickly that the speed difference between formats is in practical terms a nonissue. Quality is paramount, though: Which codec and settings sound best to normal people under normal listening conditions?

EXTREME CONTRIBUTOR:

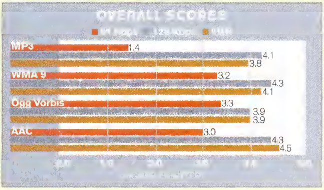
Jason grew up with early Apple computers, and even at that young age would tinker with them, adding 80-column cards and additional RAM chip by chip. He was sucked into the PC world by his friend's 4.77 MHz 8088, the very height of technology for the time.

There are literally dozens of audio codecs, but only a few are really relevant. For our testing, we focused on the four most popular ones: MP3, AAC, Windows Media Audio 9 (WMA), and Ogg Vorbis. We picked four audio clips that present different challenges to compression schemes and encoded them with each codec at bit rates of 64 kbps, 128 kbps, and at a variable bit rate with 98 percent quality. We then converted these audio clips to standard CD audio tracks, which our panel listened to on their best home audio equipment and then rated from 1 to 5—higher scores were better. Note that this was a blind test; the listeners had no idea which track represented which codec or bit rate, and each CD had a different track order, selected at random.

At the space-saving rate of 64 kbps, Ogg Vorbis clearly performed best. The low-pass filters employed by these codecs are very aggressive at this bit rate; the Ogg Vorbis filter is set to a much higher frequency, and this no doubt plays an important role in its quality. WMA9 performed admirably; MP3 simply shouldn't be used at all, if possible. But even the best encoder didn't manage a score higher than 1.5: Files sounded as though they were being played back through a tin can and string.

A rate of128 kbps ain't exactly space-eating in today's world, but it's twice as much data as 64 kbps, and that makes all the difference. MP3 and Ogg Vorbis scored nearly the same, right around 4, which amounts to pretty good sound reproduction. AAC ends up matching WMA9 at this bit rate, and their scores look very good. The variable bit rate scores are lower than the scores for 128 kbps, even though we set our encoders to target a 98 percent quality rate and the resulting files were often two to four times the size of the 128-kbps files. Also, the low-pass filters are much less aggressive with these high variable-bit-rate settings. So why the lower scores? The variable-bit-rate settings may be more accurate than the 128-kbps versions. Most of the noise in a recording resides at very high frequencies. The low-pass filter that eliminates high-frequency sound at 128 kbps may be removing some of the subtle nuances of a recording, but it also eliminates most of the inherent noise. Our audience, not knowing what codecs or bit rates they were listening to, may have thought the variable-bit-rate encodings sounded worse than the 128-kbps samples *because* they more accurately reflect the noise in the source material.

Both AAC and Ogg Vorbis made very strong showings here, and we have no problem recommending both based purely on sound quality. Unfortunately, they both have limited adoption in hardware, which limits their usefulness. AAC has an advantage with the iPod—one of the very few devices to support the format. Ogg Vorbis's main advantage is sound quality, especially at the low 64-kbps bit rate. WMA9 seems to hit the sweet spot between quality and compatibility. There are a great many popular applications that support the standard for both encoding and decoding, and all the popular portable players support the format. It often scored highest in our listening tests, and when it didn't, it was close. The main drawback is its lack of compatibility with the iPod—and the fact that it's from Microsoft, of course.



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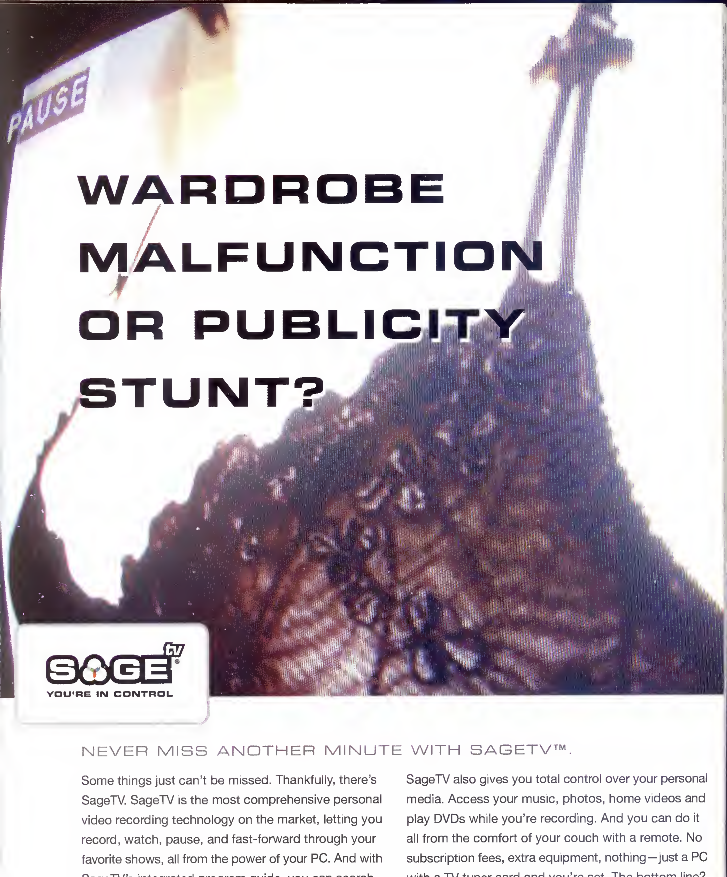
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for this system: We have yet to see a single blue screen of death. Plus it has motherboard-down USB 2.0, Gigabit Ethernet built in to the chipset, and a discrete FireWire solution—that's three very fast data pipes for getting multimedia bits in and out of this box.

CPU We went with a 2.8-GHz Pentium 4 with the 800-MHz front-side bus, which for playback is really overkill. For encoding, however, you want horsepower and lots of it, so you can get through those progress bars faster. In addition, this box can deftly run any PC game you'd want to play in your living room, though it's true there aren't many PC games you can play easily from your couch. But sports titles are a notable exception, and this machine will run them with aplomb.

Graphics Card For an extreme rig, there's really only one choice, and that's the ATI All-In-Wonder Radeon 9800 Pro, which combines ATI's years of experience making these versatile products, the venerable Radeon 9800 GPU, and ATI's polished set of multimedia apps, which now includes the EazyLook full-screen TV–friendly UI. A great feature of the All-in-Wonder Radeon 9800 Pro is the optional component video output adapter, which can be purchased direct from ATI for $29. This lets you connect the graphics card directly to your HDTV, supporting 480i, 480p, and the true HD 720p and 1080i resolutions. If you're interested in a low-cost graphics/tuner, check out the nVidia Personal Cinema or All-In-Wonder Radeon 9000; you can get either for under $200.

Sound Card We went with the Creative Audigy 2 ZS Gamer; for around $110, it gives you all the functionality you need for DVD (video and audio), TV, and gam-ing audio. The card supports seven-channel output (6.1, analog-only), DVD-Audio (analog output only), and Dolby Digital (via analog or S/PDIF). We suggest installing a minimum of Creative's copious bundled software, since you won't need much of it for this machine. In fact, all you really need is a mixer and the EAX effects panel to tweak your audio output.

Hard Drive We've made the switch, and it feels so good...to SATA, that is. It took a while for capacities to make sense for a PVR, but the Western Digital Caviar SE WD2000JD (a 200GB drive for just $150) makes the cut. A 200GB drive holds nearly a quarter of a terabyte. That should cover most of Monster Garage, right? Recall, however, that even recording a "DVD-class" video bitstream is still going to top out at a (non-)whopping 9.8 megabits per second, which is roughly 1.25 MBps or 4.5GB per hour. Most DVD streams probably average between 3 and 5 Mbps or 2.25GB per hour at the high end, so you should be able to get at least 90 hours of DVD-quality video onto that 200GB drive.

DVD Drive The standards war between DVD+R/W and DVD-R/W took a dramatic turn recently when Pioneer, one of DVD-R/W's staunchest supporters, began producing combo drives. We're sticking with the Philips DVDRW228 combo drive, which is a DVD, CD-R/W, and DVD+/-R/W drive all rolled up into one. This one can read and write just about anything and will play your DVD and DVD-Audio discs just fine, too.

Keyboard/Mouse Gyration makes a USB RF mouse/keyboard combination that features a light, laptop-size keyboard (with full-size keys) and a mouse with a gyroscopic sensor inside. The mouse arrives with rechargeable nickel hydride batteries and a recharger. Battery life is pretty good, and the unit can go several days between recharges. We really like the well-designed recharger cradle, where you rest the mouse so it's always charged. The keyboard runs on four AAA batteries but can't be connected to the recharger, unfortunately.

Remote Control We considered adding the infrared StreamZap to the mix of components here, but ATI's Remote Wonder gets the job done quite well, particularly with our current TV watching/recording app of choice, Beyond TV. And because ATI's remote is RF, it has a very long range: It will even drive a PC located in another room in your house. The range is so good, in fact, that ATI has a channel-selection feature, so that you can assign a Remote Wonder to talk to a specific PC on one channel and one channel only. That way, if you have a second Remote Wonder it won't interfere with the first or its PC.

Beyond TV 3 Of all the time-shipping apps we've looked at, Snapstream's Beyond TV 3 does the best job of bringing together TiVO, scheduled recording, and video playback in a single package, which features a friendly UI any family member can navigate. Beyond TV works well with the All-In-Wonder 9800 Pro, and even features its own daemon for the Remote Wonder.

PowerDVD 5.0 XP Beyond TV is just for TV, however; it lacks its own DVD decoder. ATI's DVD decoder does a great job, but we wanted to go all out for this Extreme PVR. In order to get DTS decode support, as well as a great video decoder, we installed CyberLink's PowerDVD 5.0 XP. In addition to DVD playback, PowerDVD does screen captures, multichannel audio, and even DivX. **X**

XTIPS

- **Finding the right case** makes a world of difference, turning an ordinary PC into something that looks and feels like an appliance. We like cases from Ahanix, Hush Technologies, Antec, and Silverstone.
- **Fan noise** ends up being a surprising irritant when you're trying to watch a movie. If you can't afford (or aren't interested in) a specially designed case, swap out the built in 80-mm case fans for slower moving 92-mm models.
- **If you feel up for adventure,** consider helping out with the myriad Linux projects that are currently being developed. We're fans of MythTV, for one.
- **Changing channels** on a set-top box box is often a necessary evil: Many cable companies routinely scramble *all their* signals. An IR blaster will let your PC do the work of your cable remote.

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BUY IT

THE EXTREMETECH GUIDE TO BUYING HDTV

Buying a digital television can be an exercise in frustration and anxiety. Like Alice's trip through the looking glass, it seems surreal and inviting, with promises of a digital Wonderland. But there are dead-end traps for the unwary. We cut through the confusing jargon and conflicting claims.

/ Loyd Case

Who knew mere television could get so complicated? The different formats, television technologies, and even inputs are enough to make your head swim. First things first: Before you rush out to buy your swank new high-definition TV, you need to figure out how you plan to receive your HDTV signals. There are three primary sources: satellite, cable, and over-the-air broadcasts. Over-the-air broadcasts are akin to traditional broadcast TV, except that signals are broadcast digitally and offer higher bandwidth. Quality varies from one region to another, or even within regions. When HDTV broadcasts were first initiated, some locales suffered from severe *multipath* problems: Reflections from buildings would cause multiple ghost images on screen. That's been solved for the most part, but if your primary source will be broadcasts, you'll need a good antenna. One place to start your search is the CEA's antenna site, *www.antennaweb.org*. It lists the best type of antenna for you, based on the type of building you're in and the presence or absence of nearby high structures. What you'll need is either an HDTV with a built-in ATSC broadcast tuner or a display-only monitor and an external tuner.

GETTY IMAGES

Cable networks lagged behind in delivering high-definition television. Part of that was an infrastructure issue: The companies had to invest in new equipment to support HDTV. But part was organizational, too. The cable companies wanted to avoid the proliferation of delivery mechanisms. This was driven by the HDTV manufacturers, who wanted to avoid the early mistakes of digital cable, such as multiple set-top boxes that wouldn't work across different areas. So they worked through Cable Labs and developed a unified standard for cable HDTV.

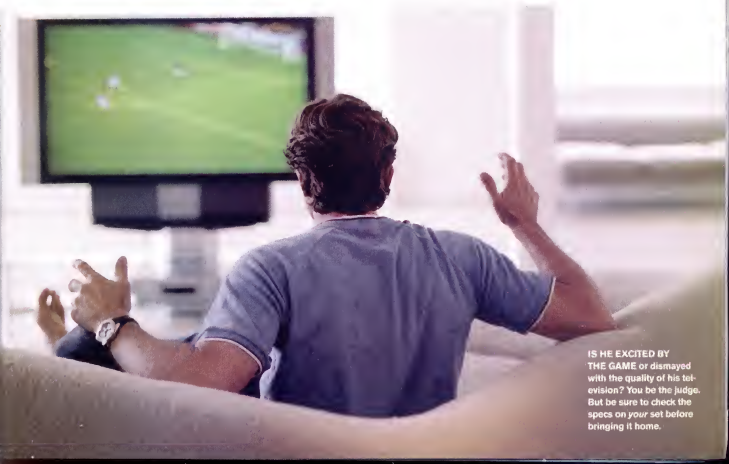
The core standard is called *CableCARD,* which defines both a delivery and identification mechanism for cable HDTV tuners. If you have satellite TV, then you'll instantly understand how CableCARD works: The ID mechanism is similar to the satellite system's smart cards. Quite a number of HDTV manufacturers have committed to building in CableCARD-equipped tuners, so if you're interested in obtaining HDTV from your cable provider, you'll want either a CableCARD-ready TV or an external set-top box that supports the standard. Few HDTVs support CableCARD today, but many are expected to shortly.

By the way, the first-generation CableCARDs do not support interactive services like video on demand; you'll still need a set-top box from your cable provider to use those features. New "two-way" CableCARDs supporting interactive services are due next year. Some interactive services (such as pay-per-view movies) will still be available but will require a phone connection.

The two major satellite providers—DirecTV and Dish Network—have both been delivering HDTV content for some time now. Dish Network is even offering bundle deals that include direct-view or rear-projection HDTVs. The only downside is that the signal is heavily compressed: Some satellite high-definition signal streams are compressed to as little as 5 to 8 megabits per second (Mbps). Needless to say, this has an adverse effect on image quality. (A properly compressed 1080i signal stream moves at around 19.2 Mbps.) A new satellite TV service, VOOM, is stepping into the breach. Launched by Cablevision, VOOM is committed to delivering HDTV signals at a minimum rate of 12 to 13 Mbps. The service is ramping up pretty rapidly, but it's still the new kid on the block. Whether it will succeed or fail depends, of course, on how many subscribers Cablevision can sign up.

DTV vs. HDTV

To qualify as HDTV, the broadcast (and the display) must support a resolution of 1080i or 720p. Of course, some low-cost analog TVs can't even deliver full-resolution *standard* TV images. The key point is that 1080i is interlaced. A full frame consists of two 1,920-by-540-line fields, offset slightly. Your brain combines the two fields, so you see a single, full frame. On the other hand, 720p is progressive, so the entire frame is output to the display. The field rate of standard 1080i broadcasts is 60 Hz, and the frame rate is 30 Hz, whereas the frame rate of 720p is 60 Hz.



IS HE EXCITED BY THE GAME or dismayed with the quality of his television? You be the judge. But be sure to check the specs on *your* set before bringing it home.

You might be confused when you hear a discussion about the similarities between *digital television* (DTV) and *high-definition television* (HDTV). Both have the letters *DTV* in their respective acronyms, but they don't mean the same thing. HDTV is, in fact, a subset of digital television. HDTV refers *only* to 720p and 1080i. Digital television simply means that the TV signal is broadcast digitally, whereas the actual resolution can vary from 480i to 480p to 720p to 1080i. But only the 720p and1080i resolutions qualify the image as high-definition.

HDTV is compressed using MPEG-2 before it's broadcast. A properly compressed HDTV signal delivering 1080i content travels at about 19.2 Mbps, but the actual bit-stream rate can vary. Note that some HD content providers compress the signal to a greater degree, so you may see attempts to deliver streams that are as low as 5 to 6 Mbps. Unfortunately, there is no easy way for a consumer to determine the actual bit rate, other than seeing decreased image quality. In fact, many HDTVs don't even tell you the active display mode (1080i, 720p, 480p, or 480i), and none of today's HDTV sets can display all the formats natively.

If you want a true HDTV experience, find a TV that supports either 1080i or 720p. You may get a pretty darned good picture out of a 1,024-by-768 display, but it's not true high-definition.

COMPARING VIDEO STANDARDS

Standard	Details
720p	1,280 x 720, progressive scan
1080i	1,920 x 1,080, interlaced
DVD-Video	720 x 480, progressive scan
480p (Digital Television)	704 x 480, progressive scan
480i (Standard Definition TV)	704 x 480, interlaced

To qualify as HD a broadcast must support 720p or 1080i. To say you watched HD, your TV has to support that spec too. Here's a breakdown of the various video standards you'll see as you channel surf.

Resolution Confusion

The fact that two different, supported HDTV resolutions exist is the source of great confusion. After all, if you have a display that supports 720p, how can it display 1080i? Any PC user with a multiscan monitor (as most are, these days) can probably guess that the display will sync to different resolutions. That's part of the story, but it's not the entire picture.

In fact, a 720p HDTV can display a 1080i image and vice versa. The TV simply downscales or upscales the image as needed. But since the image consists of multiple frames (or *fields*), it's challenging to scale the image properly. Some TVs handle scaling better than others. In fact, you'll see TVs with all kinds of oddball resolution figures. We randomly sampled actual digital televisions, to measure their native resolutions: Actual resolutions were all over the map. We sampled six TVs; two of them—42-inch models from Panasonic and NEC—don't offer true HDTV resolutions. But they will downscale high-definition streams to their native resolutions.

The key is this: If you want a true HDTV experience, find a TV that supports either 1080i or 720p. You may get a pretty darned good picture out of a 1,024-by-768 display, but it's not true high-definition. Be sure to check the native resolution of any digital display before you buy it. Actually, only a small handful of TVs support (or come close to supporting) the true 1,920-by-1,080 resolution of 1080i, so sets claiming native 1080i aren't really at that level in horizontal resolution. Advertising and spec sheets are littered with terms like *virtual HD, 1080p input,* and other meaningless expressions. Make sure you nail down the native resolution and that it's really at least 720p. Otherwise, what you're getting is an image that's scaled to a lower resolution. Many low-cost plasma sets with resolutions of around 852-by-480 are listed as EDTVs, and though they can look darn good for DVD content, they are not high-definition.

One final note: This year, we'll see a considerable number of fairly pricey displays that are truly 1,920 by 1,080 pixels. These are

GUESS THAT RESOLUTION!

Product	Native Resolution
Panasonic TH42PA20UP 42" Plasma	848x480
Panasonic TH50PX20UP 50" Plasma	1366x768
Pioneer Pro1000HDI 50" Plasma	1280x768
NEC PlasmaSync 42XM2 42" Plasma	1024x768 (widescreen)
Samsung HLN507W 50" DLP Rear-Projection TV	1280x720
Sony KDF-60XBR950 60" LCD Rear-Projection TV	1386x788
Mitsubishi WL-82913 82" LCoS Rear-Projection TV	1920x1080

A 720p HDTV can display a 1080i image and vice versa: They simply downscale or upscale as needed. But since an image consists of multiple frames (or fields), properly scaling it is challenging. Some TVs handle this task better than others. In fact, you'll see TVs with all kinds of oddball resolution figures that need to scale all the time. Here's a table of some randomly sampled actual digital televisions, and their native resolutions. As you can see, actual resolutions vary all over the map.

DISPLAY TECHNOLOGIES

Methods for getting the picture onto your screen are among the fastest evolving technologies in consumer electronics today. Here's a quick breakdown of what's hot / Loyd Case

Cathode-Ray Tube

CRTs are purely analog devices. If you hook your PC up to a CRT HDTV, you may be surprised to find that it can support merely 1,024-by-768...if you're lucky. But since 1080i is interlaced, the TV only needs to support 540 actual lines of resolution. The horizontal scan lines aren't treated as pixels by the time the electron beam paints the line. The gating factor is electron beam spot size along with the number of holes or slots in the tube mask. Additionally, CRTs are still the best displays available to resolve standard television: The analog nature of the CRT masks the image defects in NTSC TV. And CRTs can resolve better details in deep blacks, though the best digital displays can look pretty good. Also, CRT HDTVs have the benefit of being considerably cheaper than their digital cousins.

DLP Rear-Projection TVs

All Digital Light Processing (DLP) rear-projection TVs currently shipping support 720p and use Texas Instruments micromirror chips. These are typically HD2 or HD2+ chips, though some newer models use TI's HD3 chip. HD3 offers better low-light detail at a lower cost. DLP rear-projection TVs are shallow (less than 20 inches deep) and light (less than 100 pounds). They have fairly wide fields of view from side to side, but the vertical viewing angle is less robust. DLP TVs often offer very bright images, but they lose detail in very dark scenes. This makes them good for family rooms or living rooms with lots of windows, but they're not ideal for movie buffs who like to watch in darkened rooms.

LCOS TELEVISION

The 55-inch Philips Cineos 55PL9774/37 costs about $3,600.

LCD Rear-Projection TVs

Picture three high-resolution LCD panels, each with independent color filters to resolve the red, green, and blue portions of the light spectrum. That's an LCD rear-projection TV. Light is beamed through the panels, then routed through an optical subsystem to the screen. These TVs are somewhat heavier than DLP rear-projection units, but they're still considerably lighter than CRTs. Like DLP rear-projection TVs, they are fairly shallow, usually 22 inches or less for larger displays. LCD rear-projection TVs have been faulted for a noticeable "screen door" effect, in which the area between the individual pixels is visible and often distracting, particularly in bright scenes. Current models look seamless from a distance, though the lines are still visible up close.

LCD REAR PROJECTION

You can find the 50-inch Sony Grand WEGA KF-50WE610 for $2,800.

LCoS

LCoS is short for *liquid crystal on silicon*. It's a way of building a small LCD device using silicon wafers as the substrate instead of amorphous silicon, the primary material for current LCD flat panels. Like DLP, LCoS is reflective (whereas panels in LCD rear-projectors are transmissive—that is, light shines through them). The big news in LCoS is Intel. As part of its digital home push, Intel will be building LCoS chips and light engines. The first chips will support 1,280-by-720p, with 1,920-by-1,080p following later. To date, LCoS units have been fairly high-priced, though you can find some models with prices comparable to those of equivalent DLP and LCD rear-projection TVs.

Plasma

Plasma displays consist of thousands of tiny cells containing gases that are ionized by current passing through the cell. The ionized gas emits UV energy, which excites a phosphor on one end of the cell. Three cells—red, blue, and green—make up a single pixel of a plasma display. The resolutions of plasma displays vary greatly, but most true high-definition panels are at least 42 inches in size. Plasma TVs, while thin, are heavier than digital rear-projection TVs and LCD flat-panel units. A 61-inch model can weigh in excess of 200 pounds. Plasma panels have viewing angles wider than those of LCD flat panels and even most digital rear-projection panels. And plasma panels offer faster response times, so image ghosting is far less prevalent. Plasma TVs carry some danger of burn-in, and they decay over time, but today's plasmas offer substantially longer life spans than older ones.

LCD

LCD TVs are very bright in clear light, so they are well suited for daytime viewing in lighted rooms. Also, it's quite easy to build a high-resolution LCD panel. So true 1080p LCD panels at 42 and even 46 inches are already available. Panel sizes of 60 inches may arrive next year, but not in large quantities. Even small LCD TVs, such as the widely available 17-inch wide-screen units, offer 1,280-by-720p resolution or better. Manufacturers are working hard to overcome some of the shortcomings of LCD panels. Response times are down to 25 ms or less, although true "gray-to-gray" response times are still pretty long. And though the LCD color gamut isn't as wide as that of plasma or CRT TVs, video processing technology has substantially improved color and video image quality.

LCD TELEVISIONS

This 30-inch LG Flatron L3020T LCD panel sells for about $3,000.

often labeled "1080p." Note that no high-definition content provider actually broadcasts in 1080p, so 1080p displays will deinterlace a 1080i signal or upscale a 720p signal, as described earlier.

Which connections your TV supports can affect other peripherals you buy in the future, and it may even determine how soon your newly purchased TV becomes obsolete.

Display Technologies

Methods for getting the picture onto your screen are among the most quickly evolving technologies in the consumer electronics industry. The net result is a vast array of products, all with different feature sets and capabilities. The confusing morass of display types is probably the primary reason that people throw their hands up in the air and give up when trying to buy an HDTV.

If you walk into a store today, you'll find three types of high-definition displays. We'll walk you through them.

Monitors. Although you may see these referred to as HDTVs, they are, in fact, not televisions, as they lack tuners of any type. If you buy a monitor, you'll need to add a tuner. Note that most cable TV and satellite set-top boxes are tuners too, but if you want to watch HDTV, you'll need a high-definition-capable tuner. Why would you buy an HDTV monitor? If you already have a HD-capable digital set-top box or satellite tuner, you really don't need an integrated tuner. You won't save a lot of money, though, by buying a monitor without an integrated tuner.

HDTVs with standard NTSC tuners. These let you watch standard, analog TV off the air or through a set-top box. This may seem a bit odd. Why make a high-definition TV with a standard TV tuner? The answer is mostly historical. When these TVs were on the drawing board, off-the-air HDTV tuner technology was expensive, and the technology was evolving so fast that many manufacturers didn't want to risk integrating a pricey high-definition tuner that could quickly become obsolete.

HDTVs with integrated high-definition tuners. The older models will likely have over-the-air, ATSC-only broadcast tuners, which require an antenna and can only receive over-the-air broadcasts. Many newer HDTV displays shipping this year will ship with a high-definition, cable-ready tuner capable of handling the QAM (quadrature amplitude modulation) signal that cable broadcasters will use to pipe HDTV signals over your cable TV link. Note that you will really want a CableCARD-ready high-definition tuner if you really plan on buying high-definition cable TV service. CableCARD uses a type of smart card to identify and authorize the user of the unit.

To date, no major supplier of HDTV displays is shipping an HDTV with an integrated satellite HD receiver. We don't have the space here to go into the pros and cons of the various display technologies—that's a story in itself. But we've provided you with a quick-reference guide to give you some basic facts (see "Display Technologies").

HDTV Pricing

That sexy, 61-inch plasma HDTV may be enticing, until you realize that it will set you back as much as $15,000. On the other hand, a 60- or 61-inch rear-projection digital TV that's less than 20 inches deep may cost well under $5,000. And you can find 50-inch CRT rear-projection units for under $2,000.

The pricing landscape is shifting pretty rapidly. More plasma and LCD TV manufacturing capacity is coming on line this year, so prices should stabilize or even come down a bit. But the cost of actually making the panels is fairly fixed, so big, thin displays will likely remain very expensive. Digital rear-projection TVs, however, will be trending down the price curve this year. By year's end, we could see 40-inch, 720p rear-projection units selling for as little as $1,500. That's approaching the price of lower-cost CRTs. So if you're in the market for these types of HDTVs, you should keep a watchful eye on pricing, especially around the holiday shopping season.

Making the Connection

We almost forgot to mention one important item you need to consider: how to route the video and audio signals. Most HDTVs have a broad array of connection types, but certain choices may be preferable to others. This may seem like something you need to worry about only after you bring your HDTV home. But which connections your TV supports can affect other peripherals you buy in the future, and it may even determine how soon your newly purchased TV becomes obsolete.

Almost all current HDTV displays offer component video inputs. Component video connections come in two flavors: those with external sync (typically five connectors) and those without (three connectors). In both setups, the signal is split into three components, usually labeled *Y, Pb,* and *Pr.* The Y component is not the color yellow but the *luminance* (or brightness) of the signal, and it delivers the gray-scale image. Pb and Pr represent, respectively, the difference between the blue signal and the luminance and the difference between the red signal and the luminance.

Since almost all high-definition displays ship with component video inputs, this is a good fallback, even though it's not a truly digital signal path. The quality of the component video signal depends greatly on the digital-to-analog signal conversion that occurs in the set-top box or HDTV tuner before the analog signal is sent to the HDTV. If the TV is a true digital display, an additional analog-to-digital step occurs inside the TV itself. Given those conversion steps, it would be great to keep the signal entirely digital. And in fact the industry is moving rapidly towards an all-digital transport chain. No fewer than three different digital delivery mechanisms now exist for moving the signal from the digital tuner to the HDTV.

The first of these—and the earliest to arrive—is FireWire (IEEE 1394a). For a while, it looked as though FireWire would become the de facto standard, especially as High-bandwidth Digital Content Protection (HDCP) was added to systems that supported FireWire. That would have been great: FireWire can also act as a networking mechanism, allowing multiple peripherals to connect. Sad to say, FireWire was for the most part a no-go. A number of manufacturers do still support it, of course, most notably Mitsubishi, which uses FireWire in its line of HDTVs and in a number of set-top boxes and digital TV tuners that deliver high-definition content. A few high-end DVD players and A/V controllers also support the standard. FireWire can even deliver digital audio signals as well as digital video.

A more common method of delivering the video part of the signal is DVI-D. DVI, or Digital Visual Interface, is commonly available in LCD computer displays. DVI-D, which passes only digital signals, is the connection of choice for many HDTV displays today. Plus there's an added bonus: Every HDTV with DVI supports HDCP, required for sources that deliver DVI-D signals.

But DVI is also being phased out for yet another connection, known as HDMI (High-Definition Multimedia Interface). HDMI is a very high-bandwidth standard (it runs up to 5 gigabits per second), and it supports HDCP as well. This is much higher bandwidth than FireWire's 480 Mbps, so its useful life is potentially longer. The internal video signal is also compatible with DVI, so integrating HDMI into new hardware is fairly straightforward. Unlike DVI, HDMI also serves as a digital audio transport and can serve up full 7.1-channel digital audio as needed by the A/V electronics.

Your best chance of avoiding obsolescence is to buy peripherals that support HDMI. Bear in mind that HDMI is fairly new, but the consumer electronics companies are aggressively deploying HDMI-equipped displays, A/V receivers, DVD players, and set-top boxes this year. If you don't own HDMI gear currently, other connection methods will be supported for years to come, so don't start tossing out all your gear immediately. In fact, if you buy a DVI-equipped HDTV today, simple HDMI-to-DVI converters will be readily available.

A 61-inch plasma HDTV may be enticing, until you realize that it will set you back as much as $15,000. On the other hand, a 60- or 61-inch rear-projection digital TV that's less than 20 inches deep may cost well under $5,000. And you can find 50-inch rear-projection CRT units for under $2,000.

Final Thoughts

We've only barely scratched the surface of HDTV technology in this overview. Once you bring your HDTV home, issues like image calibration, tweaking the audio setup, and integrating an A/V preamp or receiver all add to the volume of stuff you have to know. It's a far cry from buying a 27-inch NTSC TV and plopping it down in the family room.

The situation is made more difficult by the cost. Even low-cost HDTV is still considerably more expensive than basic TV. But the cost of smaller units is dropping rapidly. Recently, one editor at *PC Magazine* bought a 26-inch Samsung wide-screen HDTV for under $700. But once you get the HDTV set itself, you'll find it all too easy to start ratcheting up the ante. Do you want a full home-theater A/V setup with six or seven speakers and a subwoofer? What about specialized seating?

As these thoughts whirl through your head, just take a deep breath and focus on your goal. Maybe you do want the best possible home-theater system, right down to the popcorn maker in the corner. Or maybe you just want to watch "Monday Night Football" in high definition. Just remember to take your time and look at a lot of different TVs before making your choice. Your patience will be well rewarded, come game time. **X**

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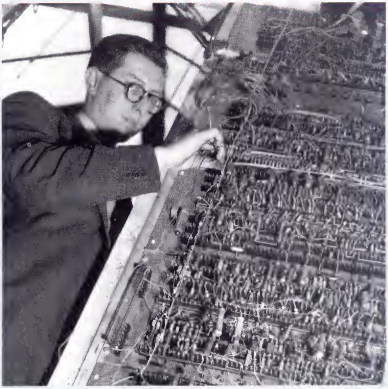

GETTY IMAGES

YOUR OWN

- In-Car GPS Navigation System
- Outdoor High-Gain Wi-Fi Access Point
- Arcade Controller
- High-Definition Home Theater PC
- Home Linux Server

MORE DIY PROJECTS FOR THE **GEAR-HEAD**

You got your start working on computers, but there's so much more to create! It's time to build on the knowledge you've gleaned putting together PCs. Start simply, with a little think-outside-the-box project: **Use a GPS navigator** and the included software to turn your laptop into a car naviagation system. Then move on to **configuring and installing Linux.** We show you how to set up a serious file server. And how about a **high-definition TiVo** system? Then the real building begins. If you've got broadband and a wireless network, you can set up a high-powered **Wi-Fi network for your entire neighborhood** to share. (Just beware the FCC—there's a laundry list of regulations.) And finally, with the right collection of push buttons, you can **build an arcade controller** just like the Pac-Man machine you loved as a kid. There's so many great uses for technology, the only tough decisions is figuring out where to start. Try turning the page...

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- **outside the box** (using anything but a standard pc case)

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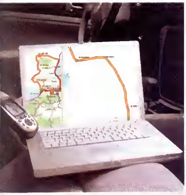
Sophisticated maps, GPS, and speech technologies add up to automated assistance. Sometimes we all need a little help, be it living or computerized. / Barry Press and Marcia Press



CHRIS STEIN

BABY, YOU CAN GUIDE MY CAR

GPS position identification anywhere on the Earth, digital map data, and route computations on a laptop PC creates a navigator able to give you route directions from wherever you are to wherever you want to go. Make the entire Street Atlas USA 2003 program, as well as a GPS, permanent additions to your laptop carrying case. On the road again...

WHAT YOU NEED

ExtremeTech Toolbox
PLUS:
GPS Receiver
Power Converter
Laptop PC

Your partner was told to visit a new, plum client and handed a ticket to Tuscon, Arizona. The client, according to the boss, is just outside of town, in Sierra Vista. Your partner never returned and was never found. The client still wants to see someone, though, so the boss hands you a duplicate set of tickets and wants you on the plane this afternoon. You trundle off. Not directly to the airport, however—you stop at your desk, fire up DeLorme's Street Atlas USA 2003, and plot a route from the Tucson airport to Sierra Vista. Looking at the result, you conclude your boss is either homicidal or a moron, because Sierra Vista is slightly more remote than the middle of nowhere.

Asking for Directions May Not Be a Guy Thing, but Electronics Are

Let's assume your boss isn't homicidal (he must just be stupid). But you don't have to be lost on the way out there. Follow these plans to build an in-car navigation system to watch over you. You'll need a GPS receiver, of course; try the DeLorme Earthmate we used, a DeLorme Tripmate, or any fully compatible NMEA receiver from Brunton, GARMIN, Lowrance/Eagle, Magellan, Rockwell/Conexant, or Trimble. We suggest a power converter to transform the 12-volt DC in your car to the 120-volt (or 240-volt) AC your laptop requires. You plug your usual laptop power brick into the converter. We've also used mobile laptop power adapters that plug directly into the 12-volt DC source (ours is from Xtend Micro, now part of iGo, at *igo.ententeweb.com*), but they're significantly more expensive than a DC-to-AC converter.

Driving with Your Navigator

To set up your navigator, first install the GPS receiver in your car. Put it in a place where it has an unobstructed view of the sky; it has to talk to the geosynchronous satellite over the equator that transmits the WAAS signal (short for Wide Area Augmentation System). The best spot is probably the junction between the dashboard and the windshield. A suction cup on the receiver's USB cable anchors it to the windshield. We thought about suspending the receiver under our car's convertible top, but the dash gives good enough GPS and WAAS coverage for all headings except due north, when the WAAS signal tended to disappear. And if the soft top had any conductive component, that placement wouldn't have worked well. Similarly, if your windshield has a metallic screen, you may find GPS reception is poor.

Most laptops include hardware and soft-

USEFUL TIP

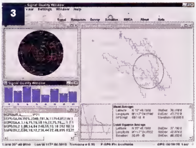
1 We put the GPS receiever on our dashboard, but metal in the windshield might cause interference. You can find a list of vehicles whose windshields contain metal at *www.e-zpassny.com/static/info/exteriortags.html.*

ware for power management. If you skip a DC converter, turning off the LCD is the first thing you can expect the power management to do: The display eats from 30 to 40 percent of the total system power. Your system will continue to monitor the GPS and announce turns with the display switched off, but if it spins down the disk or puts the laptop into suspend mode, everything stops. We countered by turning on presentation mode, meaning all power management is temporarily turned off. Battery life suffers because of that, which is why we recommend a power converter for anything but short trips. And with the display off, you won't be able to monitor your progress on-screen.

Once you get rolling, the rotating map view centered on the GPS location ensures the map display matches what you'll see out the windshield. Don't be surprised when the directions seem inappropriate. We've had the navigator tell us to turn onto a street when we had no choice but to follow a bend in the road, making the directed turn pointless. The navigator gives these false directions in response to street name changes or other information in the underlying map database. The navigator will tell you how to fix the problem when you make a wrong turn. The display will highlight the original route it plotted, the new route it's suggesting, and the path you eventually take. There's also a back-on-track function in the software that lets you command the computer to plot a new route based on your current location.

2

3



Combine Street Atlas USA 2003 (figure 2 shows a map view from the program) with the great data from VisualGPS (shown in figure 3) for the ultimate navigation aide.

Of course, driving with a GPS and navigator can lead you into trouble if you're not careful when you plan your trip. Enough cell phones, computers, and satellite visibility to kill a horse won't help if your cell phone has no signal when you have a breakdown—you could be stuck until someone shows up.

The other problem lies in GPS coordination. Imperfect alignment of the two to four satellites that track your position may lead to positioning errors. One of the ways you can improve the GPS estimate is to average position measurements over a log interval. The VisualGPS program (*www.visualgps.net/VisualGPS*) reads data from your receiver, decodes it, and plots the result (see figure 3).

But back to you and your homicidal boss. When you return to your office, safe and sound, take note of his reaction. Was he really expecting you to come back? This should determine once and for all whether he's a killer. Or you could just check his nameplate: "Sorry Mr. Bundy, but I don't think I can work here any longer."

Future Projects

We've set the stage for you, grasshopper. But Running Street Atlas USA 2003 with your GPS on your laptop is just the beginning of what you can do. And we're not going to tell you how to do the rest of this stuff: We're just going to leave you with a few ideas to get you started. If you build a Windows processor board and LCD into your car, you could include an MP3 library, a player, and a GPS navigator. You'll need to ruggedize the installation somewhat so that it can handle heat dissipation, shock, and vibration, as well as clean up noisy power. Sourceforge (*www.sourceforge.net*) has lots of software you can use that works with an NMEA-compatible GPS, or you can use the commercial products we've listed here. You can also find a lot of useful information on GPS and NMEA at *www.vancouver-webpages.com/peter.*

Different grades and elevations present varying loads on your car's engine. If you find the engine is misbehaving on specific road segments, you can correlate data from your engine by time with a map trace recorded from the GPS data. You can get the data out of your engine using the Davis Instruments CarChip, which interfaces with your vehicle's OBD II (On-Board Diagnostics II) system.

Finally, many people are building wireless hot spots in restaurants, airports, and other popular locations. They aren't always well marked, but you can identify them and record their locations using Netstumbler (*www.netstumbler.com*). Then you'll know when and where you can surf for free.

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BUILD YOUR OWN

OUTDOOR Wi-Fi ACCESS POINT

Take your broadband network to the next frontier: The Great Outdoors. With our handy, step-by-step guide you'll be broadcasting your SSID in no-time flat. / Mike Outmesguine

There's an antenna on your laptop, one on your desktop in the living room, and a wireless router feeding them both. You can even surf in the backyard or the front yard—but not quite from the park down the street. Your neighbors are starting to ask what's going on. They're feeling left out. There's only one logical conclusion: Provide wireless Internet access for everyone on your street. Hey, why shouldn't they reap the benefits of your expertise? Besides, it's a great way to introduce yourself: "Hi, I'm the geek on your street. Would you like free high-speed Internet access?" Before long they'll be throwing parties in your honor and waving as you walk down the street with your laptop open—instead of looking at you strangely and shaking their heads. Read on and you'll find out how to get started.

Location, Location, Location

Wi-Fi range is all about line of sight. That is, if you can see the antenna you can get online. If you can't see it, all bets are off. Most of the time the antenna should be nice and high, where everyone can see it. But there's a catch-22: You need a longer cable to put the antenna in a better place, but the longer the cable, the more signal you lose. The solution? Move your access point closer to the antenna—put it right on the pole. This keeps the cable short and transfers all the power where you want it: into the air, instead of wasting power into the cables and connectors.

Your outdoor access point will need a source of power and a connection to the Internet. We'll get sneaky and provide both of those in a single cable using Power-over-Ethernet (PoE for short). Running Ethernet cable is far easier than running antenna cable: It's much cheaper, it's much more flexible, and it can go up to 328 feet without data loss. The big issue to keep in mind is safety. Lightning can strike almost anywhere, but it generally goes for high points, and if they're metal, so much the better. Take lightning protection seriously and plan for it in your installation: This protects your gear and prevents fires. Think about where the copper grounding wire will go when you're planning the outdoor location.

Parts Is Parts

The most time-consuming part of building your outdoor AP is getting all the parts together. The actual assembly takes less than two hours

LATEST HOT SPOT

It's easy as pie, we swear: Just get a high-gain antenna like this one, staple-gun it to the eaves, connect your lunch to the antenna, and... oh, just go read the story.

WHAT YOU NEED

ExtremeTech Toolbox

PLUS:

- **Access point**
- **Power-over-Ethernet adapter**
- **Waterproof box**
- **Mounting hardware**
- **Lightning protector and grounding wire**
- **Antenna and mounting hardware**
- **Matching "pigtail"**
- **Ethernet cable**
- **Electrical tape**
- **Waterproof sealant**

once you have everything in one place. You may be surprised to find that the access point accounts for less than half the total cost. Although most parts cost about $20, there are quite a few of them, and they add up fast. The high-gain antenna is quite expensive: It can cost up to $100 depending on your requirements, but the signal boost is worth the extra dough. There are two kinds of high-gain antennas: *omni* and *directional*. We recommend a directional antenna. By focusing your beam, you get a more powerful signal using the same transmission power. Also, you're less likely to cause or experience interference problems, because you can aim your transmission beam and focus your receptivity. Finally, due to the reduced potential for interference, directional antennas typically have higher gain than omnis. You'll also need a *pigtail* to attach the antenna's large-diameter cable to the small connector on the access point. Pigtails are available from several Web sites, including *www.ecwest.com*, *www.fab-corp.com*, and *www.hyperlinktech.com*.

XTIPS

- **It's possible to get a good wireless** connection through the outside walls of most buildings, but rarely through multiple walls, especially if there aren't any windows.
- **Big leafy trees will absorb** a lot of your signal, especially when they're wet. Remember the trees if you're choosing a location in winter, so the system doesn't slowly stop working as spring arrives and the leaves grow back.
- **Use natural obstacles to block** coverage where you don't want it to go. The side of a building is better than the rooftop if you want coverage confined in one area.
- **Remember:** You can use an antenna to boost reception at the receiving end. This is handy if you've found a location that's perfect except for one spot where the signal is unreliable.

The most important element is the access point, however. It's best (and cheapest) to choose an 802.11b device rather than the newer 802.11a and 802.11g equipment. The range is better (some may argue this, but we feel lower speed will allow for greater distance) and there are more equipment choices. The exact type of access point you choose isn't critical as long as it has a removable antenna so you can attach your high-gain one (many do not) and you can find a matching PoE adapter—not so easy a prospect! We used a D-Link DWL-900AP.

Manufacturers realized years ago that Ethernet cable has four twisted pairs but only two of them are used for data. Many built proprietary solutions that add power to the unused pairs, but it was years before they got together and agreed on a standard. That's why PoE is usually limited to high-end commercial equipment. Now that a standard exists (802.3af), companies are making converters that work with consumer equipment. The challenge with sending low-voltage direct current over Ethernet cable is that voltage drops with distance. Also, the amount of current is restricted by the small diameter of the wire. PoE sends a much higher 48V of direct current over the wire. This requires less current for the same amount of power, but the receiving equipment needs to convert the 48V of direct current into something usable.

We went with D-Link's DWL-P100 PoE adapter. It comes with a 48V plug pack that runs on AC power and another box that converts the 48V back into the 5V of direct current needed by the access point.

Your access point has to stay dry and remain at a reasonable temperature; ultimately, your local weather conditions will dictate the type of case you use. Continuous below-freezing temperatures or snow and ice buildup can require special solutions, including box heaters and antenna de-icing. By far the cheapest and simplest box to work with is a plastic food container. They're easy to drill, cut, and glue, and they're cheap. The main downside is that they often degrade quickly when the sun shines on them a lot. Other options include outdoor metal boxes and molded plastic junction boxes (the kind designed to be buried in soil). In addition to attracting lightning, outdoor metal boxes are airtight, so they may get too hot if you seal them completely. You'll want ventilation holes on the bottom for cooling.

Once you've chosen your box, you'll need to figure out how to mount it on the pole or wall and ground it. A good source of pole-mounting hardware is the TV antenna section of your local hardware or electronics store. Lightning protectors are special-

EASIER THAN YOU THINK!

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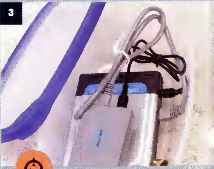


CAUTION

ized equipment; there are several good online vendors, such as *www.pasadena.net/shop, www.fab-corp.com,* and *www.hyperlinktech.com.* Plan carefully to ensure the protector matches your cable and antenna connectors. A common version is N male to N female. It can be put inline anywhere there is an existing N connector, such as your antenna. Unless you ground the protector, though, it won't do much except slightly weaken your signal strength. You'll need 8-gauge copper wire (thick stuff) from your local hardware store, along with appropriate fittings. For complete protection, this wire should run all the way to an 8-foot copper-clad steel pipe driven into the ground and connected via a special ground fitting. This isn't always possible or practical. In low-lightning areas, the wire is often taken to the nearest copper water pipe and connected via a fitting designed for grounding. If you have a metal case, you should ground it too.

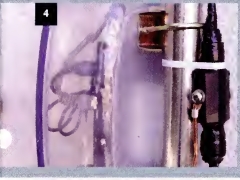
Assembly Time

When you have all the parts, plug everything in and make sure it all works and fits together. The pigtail links the high-gain antenna to the access point, but before attaching it, configure the access point to use only one of its two antennas. This is optional, but we recommend it if your access point supports it. This is also a great time to find the bad connection on that old Category 5 cable you got from your friend's garage. Use as much of the final equipment as possible, including the high-gain antenna and any pigtails. We won't bore you here with network configuration issues—that's a book in itself. Suffice it to say, make sure the router configuration is done before it's too late. When you're through testing, you'll be confident that the hardware and software setup works *before* you start cutting metal and climbing up on rooftops.

Place the access point and PoE adapter in the case and arrange them for best ventilation and fit. Then add the internal cables and confirm that everything still fits. Next, add the pigtail and outside Ethernet cable. The pigtail may be thick and stiff, so carefully anticipate where it will run. It is important to have all cables exit from the bottom of the case. This stops water from running down the cable and into the case. With everything in place, you can plan where the holes will go. Be sure to plan exactly how the case will be mounted to the pole or wall as well. Now you're ready to start drilling and cutting. With a plastic case, you can cheat a bit and cut a line down to the holes. If you're using a metal or thick molded plastic case, make much larger holes to pass the connector through. You can use sealant to fill in the gaps afterwards.

Mounting the Case and Antenna

Mount the case on the pole and then attach the antenna using the instructions that came with your antenna and its mounting hardware. Add the lightning protector between the antenna and pigtail and attach the bare copper grounding wire. Screw the lightning protector into your antenna connector and then attach the pigtail to the other side of the lightning protector. Add the 8-gauge grounding wire to the lightning protector and run it down the pole with your other cables. As you work with the cables, be sure to add *drip loops*—loops where rain will naturally drip off. This simple trick keeps water from pouring onto the connectors.



4

1. TV antenna mounting hardware like this pole and mounting bracket is widely available at hardware stores.

2. A grounded lightning protector is crucial. Hook the wire to the ground via copper-clad steel pipe—or even a copper water pipe.

3. Find the optimal device layout and cable management and ensure it all fits.

4. We've put the lightning protector right behind the access point on our pole, and waterproofed the connectors by wrapping them in electrical tape.

Use plastic zip ties to hold things in place. When all the cables are in the correct places, standard electrical tape will work great for waterproofing. Apply it liberally by wrapping from the bottom to the top with lots of overlap. You may need to remove and reinstall some of your cable ties to do this properly. Now the final step, will the box stay dry inside? Grab a bucket of water, dunk it, and find out—no, wait—just kidding!

Setting your garden hose to produce a gentle spray is a good way to start. Simulate rain by holding it above your case and leaving it there for several minutes. Place toilet paper in your case before testing to provide a fast visual indication that all is still dry. Leave everything powered off while you're doing these tests. Gradually increase the test length until you get to 20 or 30 minutes of gentle spray. Pat yourself on the back for a job well done when you retrieve your dry toilet paper afterwards. Congratulations! If the case leaks, find a tube of outdoor sealant at your local hardware store and apply appropriately.

After all the assembly and testing, everything is ready to go. Find a safe ladder and mount your new outdoor access point. Run the Ethernet cable back inside the house, plug it into the PoE adapter, and confirm that everything is working. Last but not least, find a good spot for the lightning protector grounding cable. The 8-gauge copper wire should be run via the most direct route possible to a ground rod—either solid copper, copper-clad steel, hot-dipped galvanized steel, or stainless steel. It shouldn't be smaller than 8 feet in length and 1/2 inch in diameter. You'll need fittings designed for grounding to connect everything together. Ground your case (using the same wire) if it is metal. With grounding completed and the unit powered on, you're ready to e-mail the neighbors: The nightly WLAN party gamefest is on! **X**

Based on the book Project Arcade
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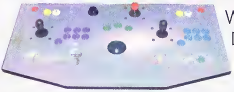
BUILD YOUR OWN

ARCADE CONTROLLER



ALL THUMBS

Invite those alien invaders back for a rematch...on your own terms, this time. Build a custom arcade controller and you'll be ready for the entire horde. Unless they're really slimy, of course.

What's your vision of the perfect arcade control panel? Does it have shiny red and blue push buttons? Is it a bat-handled joystick? Maybe you'd like a glowing trackball and a polished silver spinner? Don't buy it, silly: Build it. Read on for complete plans. / John St. Clair

For every build-your-own project in the world, there's a prefab solution you can buy instead. Game controllers are no exception. Several companies make game controllers you can buy online or at the local parts shop. "So why bother building one?" you ask. "Phooey on you-ey," we reply. "Because we can."

Building a desktop arcade controller gives you the benefits of playing with real arcade controls without losing floor space in the house to an upright, 400-pound monster. A desktop controller is also portable, for those times when you visit arcade-deprived friends. Warning! Visiting friends with your contraption can have one side effect: Shortly after playing, the question "How can I get one of these?" will come up. Direct them to our Web site, ExtremeTech.com. After all, you'll need this magazine when you start your next project.

WHAT YOU NEED

ExtremeTech Toolbox

PLUS:

Tools
Router
Jigsaw
Soldering iron
Drill

Parts
Buttons
Joysticks
Wiring block
Old keyboard
Medium-density fiberboard

Getting Started

It might seem like a challenge, but building a desktop arcade controller is easier than you think. It's simple, actually: Take the control panel from an arcade machine, and add a box around it to protect the insides. The top panel holds the joysticks, buttons, and other arcade controls. Inside the box are the underside of the controls and the electronics. The back has a hole for the cables that connect to the computer.

Before you pick up a drill, you should plan what you want to create. If you first put some time and thought into what your ideal control panel should look like, you'll be amply rewarded in terms of appearance and playability when you're finished. There's a world of difference between a well-crafted, multiplayer-friendly arcade control layout and a slab of wood with a bunch of controls strewn about. A well-crafted layout will let you enjoy the game play (which is, after all, the point of this whole thing) instead of fighting with the controls, the same way a well-designed car lets you enjoy your drive instead of focusing on finding the windshield wipers.

Choosing Your Controls

You should first decide what controls to include. You'll almost certainly want to include push buttons and joysticks in your design. It would be virtually impossible to have a functional control panel without push buttons, and one without joysticks is pointless (most games you'll be playing use them). Once you've decided which controls to include, sketch out a design. You may find when putting a concept down on paper that you do not have enough room for all your controls. From your design, you'll create a control *template*—a layout of your control panel with the controls placed on it. You can create one digitally on a computer, moving parts around in a paint program and experimenting with design. You can also experiment with the design this way: Print out images of individual arcade controls and then place them on a mock-up of a full-size template. Almost any control can be planned for with a circular, square, or rectangular template.

Proper spacing and placement of your control layout is extremely important. Spacing is primarily a function of the physical size of the controls you're going to use—and the size of the hands that will use them. Take push buttons: Physically, the largest part of the push button is the bezel that rests on top of the control panel. In the case of the Happ Pushbutton With Horizontal Microswitch, that bezel is 1.3 inches in diameter. So you *could* install a push button every 1.3 inches. When it comes time to play, however, most people will find such spacing too cramped for comfort. Control panels are usually designed with buttons 1.5 to 1.75 inches apart, which is a comfortable distance for game play. Go through the design process before you start installation, to make sure that what looks good as a concept actually feels right in practice.

You should also think about the spacing between different groups of controls, such as between buttons and joysticks. As you play, the part of your hand that's not using the control has to go somewhere. If there are buttons directly next to a joystick, you'll end up resting your hand on them. And don't forget to design for right-handed and left-handed play. The spacing may work for you, but what about someone who uses the other hand for the same control? The creative folks at move360media.com (multimedia Web site designers) have posted a tool just for people making arcade cabinets. Called the Interactive Control Panel Designer (or ICPD), it's an online tool that runs in your Web browser and lets you experiment with different control-panel layouts. You'll find it at *www.move360media.com/mame/icpd/ICPD.htm*.

Installing the Controls

It's almost time to pick up your power tools and install the controls. You'll need a drill to make holes for the buttons and joysticks, and possibly a router and jigsaw. The jigsaw helps make large openings, but woodworking veterans sometimes prefer a router for making holes and cuts instead. Some controls are designed for

BUY THE RIGHT CONTROLS

Push Your Buttons

Kapow! Jump! Kick! You'll [illegible] few games that can be played without buttons—even games that don't use buttons to play use [illegible] them to "coin up" the game and select the number of players [illegible] time. A switch sits at the bottom of the button and is activated when the button is pushed down, making contact [illegible]. This activates the electronic signal. There are two switch types: leaf switches and microswitches. Many arcade fans prefer the leaf style. They're quiet when pressed, unlike microswitches, and some people prefer the way they feel. You'll probably end up [illegible] microswitches, however, since manufacturers don't [illegible] leaf-switch buttons anymore. A microswitch is a self-contained mechanism with three [illegible] of metal coming from the sides and bottom and [illegible] the top. The bottom blade is marked COM and the two side [illegible] marked NC and NO [illegible] COM [illegible] tiny button [illegible] switch. [illegible] We like the Pushbutton With Horizontal Microswitch [illegible]

The Joy of Joysticks

You have more choices for joysticks than for any other [illegible] control. [illegible] essentially [illegible] to the next. [illegible] metal control panels, some for wood, and some for both. The difference lies in how far the control will protrude above the control panel. Controls designed for metal panels will work nicely in a wooden panel (though not the other way round); you have to recess the control into the panel from underneath. This is done with a router. If you're using a ¾-inch panel, then a depth of ¼ inch is about right. With a shallower ⅝-inch panel, you probably will want to recess the control by only ⅛ inch. If you recess it too much, you run the risk of the wood breaking. Leaving about ½ inch of wood in the panel will provide a sturdy surface.

Most buttons and almost all joysticks require a 1⅛-inch hole for mounting. You pass the buttons through the hole and fasten a mounting nut on the underside. Although the joystick shaft won't take up the entire hole, you need some room to move the stick around. The mounting plate attaches to the underside of the control panel, usually with carriage bolts from above, although some folks will install it with screws from underneath. Attaching it from underneath leaves you a smooth surface above, while using carriage bolts from above provides extra stability. We'll leave most of the woodworking up to you; you know how much desktop space you can spare.

Hacking the Keyboard Connector

Everyone who has a computer has a keyboard, but not everyone has a joystick or game pad. Software developers know this, so almost every game made for the computer can be controlled with a keyboard. You can hook your control panel to your PC through the keyboard connector.

How does it work? Pressing a key closes a circuit associated with that particular keystroke. The closed circuit is detected by a minicomputer inside the keyboard called a *keyboard encoder,* which takes information about the keystroke, encodes it in a digital form, and passes it to the computer via the keyboard port.

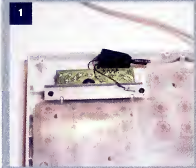
The actual physical makeup of a keyboard can vary quite a bit. A typical design includes either a circuit board or a flimsy material (called simply the *flimsy*) that lies underneath the buttons on the keyboard. Laid out on the flimsy is a maze of circuits. Directly beneath each keyboard button on the flimsy are two halves of a circuit. The underside of the button has a conductive material of some kind. When the button is pressed, the conductive material comes into contact with the two halves of the circuit below, completing it.

If a keyboard were configured to use *discrete contacts* (one contact per key), there would be more than 100 contacts required and a keyboard encoder chip with the same number of pins on it. This would be big and expensive. Instead, keyboard makers take advantage of a matrix, which uses a small number of contacts to account for a larger number of inputs by arranging them into a grid. Take a closer look at the keyboard encoder (see the step-by-step guide below): There are 14 contacts on the left and 8 on the right. If the keyboard were set up according to a discrete model, there would be only 22 buttons possible. But a matrix gives a total of 14 times 8 or 112 possible buttons—more than enough for a standard 104-button keyboard.

The keyboard encoder has a map of this matrix programmed into its memory. The *A* button is in the first spot on the matrix (located at grid coordinates *x1*, *y1*). When it's pressed, the encoder sees the circuit that connects the first contact on the 14-contact side (*x1*) and the first contact on the 8-contact side (*y1*). The encoder looks this up in its map and gen-

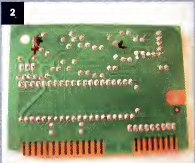
REUSE YOUR OLD KEYBOARD

1



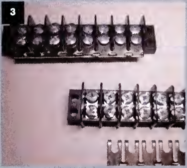
The circuit traces on the flimsy all come back to the keyboard encoder, shown in the top left. Getting it out is a pain; the odds are good that it's firmly connected to the injection-molded plastic case and the flimsy at multiple locations. Start screwing.

2



Take a close look at this keyboard encoder. There are 14 contacts on the left side and 8 on the right. We're going to map out on a paper grid what happens when each pair of contacts (112 pairs in all) is activated. Label the left set of contacts the x axis and the right y.

3



Wiring blocks are good ways to connect two components together when you don't want to simply wire directly between them. For an arcade controller, using a wiring block will let you swap in new controls without resoldering the precious keyboard encoder.

erates an *A* keystroke. The *A* key might be next, and so on. Determining which button has been pressed requires only a simple lookup in the table for the *x* and *y* value.

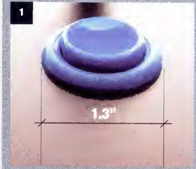
There is no set standard for how a matrix is designed and laid out, so your first hurdle will be a time-consuming one. You'll have to determine your keyboard's matrix manually. The procedure is simple (assuming you've already taken apart your sacrificial keyboard and disconnected the keyboard encoder). First, you need a program on your PC that tells you which keystrokes are generated. It's easy to tell when letters and numbers are being pressed with any word processing application. But those won't tell you if you're pressing the Left Shift key, Right Ctrl key, and so on. There are several utilities that will do just that. Download one from *www.arcadecontrols.com* and fire it up.

CAUTION

Warning! There is a 5-volt presence on the encoder board while it is connected to the PC. If something goes wrong, you could fry the keyboard port or the motherboard itself. Just be careful, okay? Start by laying out a grid on a piece of paper matching the number of *x* and *y* contacts on your keyboard encoder. Next, take a length of wire and strip off 1/4 inch of insulation from both ends. Hold (or attach with an alligator clamp) one end of the wire to the first *x* contact. Then hold the other end of the wire to the first *y* contact and note the keystroke this generates on the computer. Record it on your grid, and move on to the second *y* contact. When you're done with all the *x1* combinations, move on to *x2* and repeat. Continue until you have the entire matrix laid out.

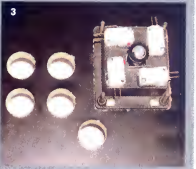
WOODSHOP 101

1



The bezel on this Happ Controls pushbutton is 1.3 inches in diameter, although the button requires only a 1.125 inch hole. Keep the bezel size in mind as you lay out and drill holes for your controls, rather than the required mouting hole's diameter; if your hands are cramped it won't be fun to use.

3



Here's the underside of our control panel, with a joystick mounted and recessed. When you're finishing the electronics, the wiring block will connect the keyboard encoder to the metal contacts protruding from the microswitches, which sit on the underside of the joystick.

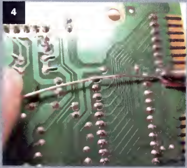
Wiring

Decide which keystrokes you're going to use for your control panel. Now you can begin to wire things up. Follow the path of the circuits to see where they connect up to solder points. This is where you can solder your own wiring.

The best way to proceed is to strip a small amount of insulation off both ends of the wire, "pre-tin" one tip with solder, and solder it to the contact point. Next, take the other end of the wire, crimp a connector on it, and attach it to a wiring block a few inches away, as shown in the figure. Repeat with the rest of the contacts. It is easiest to solder all the wires first and then attach them to the wiring block. This helps to ensure the wiring to the encoder is not damaged. You don't want to have to resolder it! Then solder your buttons and joysticks to the wiring block. Now they can send a signal to your PC via the keyboard encoder. Neat, huh?

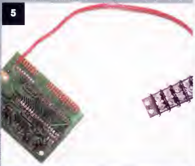
This is admittedly a time-consuming project not for the faint of heart. But the sense of accomplishment you'll gain, not to mention the interesting information you'll learn, will make it worth your while. Besides, don't Logitech and Microsoft get enough of your money already?

4



Solder a wire to the first circuit trace on the keyboard encoder. Previously, a trace on the flimsy activated this connection when the press of a button closed a circuit. You're going to wire your joysticks and pushbuttons to send the signals instead.

5



Since taking the encoder out and mapping the Matrix (where was Keanu when you needed his help?) was so time-consuming, we recommend using a wiring block to avoid damaging it. Here's the wiring block connected to the first circuit trace on the keyboard encoder.

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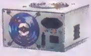

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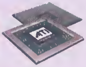

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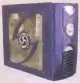

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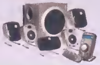

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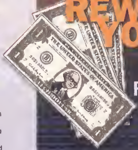

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BUILD YOUR OWN

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Sports, sitcoms, heck, even *soaps* look awesome in high-def. Preserve it permanently with an HD HTPC. / Loyd Case

LOOKS ARE EVERYTHING

The right case can make or break you. If it looks like an ordinary stereo component, the "nontechnical" members of the family don't ever need to know what's in there. But keep a parts list handy for when your geek buddies show up, of course.

The 21st century is the era of digital media. The word *convergence* can elicit yawns among the technologically savvy, but the fact is that the worlds of the personal computer and of consumer electronics are actively, unavoidably colliding. For the do-it-yourself crowd, this means the home theater PC. An HTPC can act as a high-end DVD player, a repository for digital media, and a personal video recorder.

But what if you want to pause and record HDTV? Ask most giant consumer electronics companies for a high-definition PVR and they'll laugh at you. Do-it-yourselfers, get ready: Let's build a high-definition HTPC! Today's cheap, giant hard drives are perfect for this task. Your PC is probably already a media repository, storing digital music and photographs. Add a new HDTV card and you can *theoretically* record high-definition content to the PC in all its high-res glory. In practice, this part turns out to be less than perfect. Damn! Read on before you roll up your sleeves.

WHAT YOU NEED

ExtremeTech Toolbox

PLUS PARTS:

MyHD 120 capture card ($270 street)

DVI daughter card ($90 street)

TitanTV account (free)

First Steps

Before attacking the high-definition part of the HD HTPC, we first needed to come up with a good PC. Most people will want to integrate their home theater PCs into their home theaters, though this isn't always the case. Someone in a studio apartment or dorm room might just want the PC to be the main media hub, with high-end PC speakers handling audio chores. In our case, though, we wanted to integrate the system into a mainstream home theater.

An increasing variety of cases exist for this purpose; we chose the Ahanix D.Vine 4. Though bulky, it looks much like a piece of gear someone would integrate into a midrange or high-end home theater rack. After we settled on appearance (helpful in the critical "spousal acceptance" arena), we looked at the processor and motherboard. We picked up a 2.4C GHz Pentium 4, which supports Hyper-Threading and the 800-MHz front-side bus. The companion motherboard is the Intel D865GLC, though we eschewed the integrated Intel graphics, of course. The D865GLC is actually a micro-ATX motherboard, with one AGP slot and three PCI slots. Rounding out the package was a pair of 256MB Kingston HyperX PC3200 modules, for a total of 512MB of memory.

Noise is a big concern for a PC in an AV rack. We had two interesting power sup-plies on hand. The first was a Zalman ZM300A-APF power supply. Zalman builds in some beefy internal heat sinks to facilitate cooling. The alternative was a 300W Seasonic Super Tornado 300 power supply. We used the Super Tornado, which despite its name was somewhat quieter than the Zalman unit. A Vantec Aeroflow fan took care of cooling the CPU.

The Ahanix D.Vine case has some quirks you should be aware of. First, it uses tiny screws throughout, so take care when using a screwdriver. Even the screws that mount PCI cards are extremely small. You should also watch out when installing the optical and hard drives in the drive bays. Small metal moldings actually protrude from the case front into the area where the hard drive bay mounts. Make sure to mount the drive so that the front is a couple of millimeters back from the bay edge. Perhaps most annoying is that the case doesn't have a full complement of ATX motherboard mount points. Ahanix seems to have assumed you'll always be using a full-size ATX board, and the center row of micro-ATX mount points is missing. In the end, the Ahanix D.Vine 4 is really a basic desktop PC case with some interesting cosmetic features—a sheep in wolf's clothing.

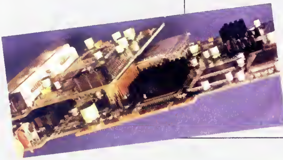
HDTV Enters the Picture

Once the main PC components were chosen, we needed a good high-definition tuner card. One of the more popular cards is the MyHD 120. It's manufactured by a Korean outfit called Macro Image Technology Co. and is capable of off-the-air reception of digital and analog TV signals using an ATI NXT-2002 demodulator chip. As such, it requires an antenna. We used a Terk TV55, which resembles a skinny cruise missile more than your typical TV antenna. The TV55 comes with gear that lets you simply attach the antenna underneath the eaves of your house if you don't want to go to the trouble of mounting it on a pole.

THE CARD
The MyD 120 is capable of off-the-air reception of digital and analog TV signals, thanks to an ATI NXT2002 demodulator chip.

XTIPS

- **Ahanix cases are nice,** but we've seen comments on the noise of the 60-mm case fans. Consider upgrading to 92-mm fans or a different case if you're worried.
- **Powerstrip, powerstrip, powerstrip!** We can't say this often enough. Experiment with this incredibly versatile tool and the odds are you'll fix most any display problem you encounter.
- **Hyper Threading** seems to be an issue for some people—though our concerns with the MyHD card weren't caused by it. Try turning it off if you need to troubleshoot.
- **The AVS Forums have a wealth** of information about HD and HTPCs in general. Check the message boards if you're confused or need help.



THE DVI DAUGHTERBOARD
The DVI card attaches via a long, exposed pin array. Take care; it's easy to bend the pins.

One cool aspect of the MyHD 120 is that it accepts an optional Digital Visual Interface (DVI) daughterboard. We were quite interested in testing this on our DVI-equipped Samsung HDTV. The DVI daughterboard contains receiver and transmitter chips from Silicon Image, letting you pass through a DVI signal from a correctly outfitted graphics card.

Once installed, the whole affair takes up two slots. Since we were using a micro-ATX motherboard, we mounted the card in the third slot; the DVI daughterboard took up a PCI bracket that had no slot present. You either need two displays (one for the HDTV card and one for the graphics card), or you can use the pass-through cables supplied with the card. The DVI daughterboard ships with a 2-meter DVI cable, which you can connect directly to the DVI input on the display device, but you'll need a second DVI cable if you also want to pass a DVI signal through from the PC's graphics hardware.

The physical setup is surprisingly easy, even with the fragile nature of the DVI daughterboard. The breakout dongle is one of the more compact we've seen, and it integrates a VGA pass-through as well if you don't want to use DVI. The MyHD 120 also ships with a compact remote, complete with tiny black text imprinted on the silver gray shell. The small keys offer fairly good tactile feedback, and the buttons are well laid out. The choice of a serial IR receiver instead of a more modern USB dongle is odd for a device likely to go into current-generation PCs, however.

Using MyHD

The MyHD HDTV card represents everything that's both right and wrong with the PC as a home theater device. Like many PC devices, it offers a great deal of flexibility but gets tripped up in the process. For example, the interface for setting up the card is a relatively poor clone of ATI's pre-8.5 software. The screens are clut-tered and assume you understand DTV jargon. There are two different screens for the display, one for "AV setup" and the other for "VGA setup." But the AV setup is where the resolution of your output device is set. The VGA setup screen defines how you want the MyHD playback window to appear on your monitor. Confused yet?

It gets worse: The capture setup screen may cause your brain to lock up. There are endless sets of options and no real guide as to which ones are best. Further, there seems to be no

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way to capture at full 720p or 1080i resolutions; the best resolution offered is 720-by-480, or enhanced DTV. (Viewing at those resolutions works just fine, however.) You can set file sizes to greater than 2GB, which is a good thing: Capture files can get huge pretty quickly.

Capture Considerations

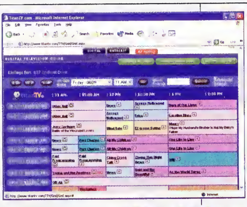
The primary reason for using a PCI HDTV card is for time-shifting your HDTV viewing and archiving your favorite high-definition shows. Secondarily, you can use the MyHD 120 to capture analog TV. If you use an IR blaster, you can even capture from a digital cable or satellite TV box, but that signal will be analog only.

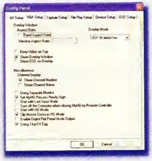
The native capture format for HDTV signals is an HDTV transport stream, which carries the file extension .tp. The transport stream contains both the digital video and audio signals, which then need to be demultiplexed for playback. You can play back TP files via the MyHD player software, which on the surface resembles most other TV-tuner-card software.

It's also possible to play back a TP file using certain DVD-player software products, such as InterVideo's WinDVD 5 or later. Or you can capture analog video to an AVI file that can be played back in Windows Media Player. Perhaps the single most confusing aspect of all this is properly setting up the video and audio codecs so that you use ones actually on your system. Otherwise, you may get audio without video or vice versa. Much depends on your sound hardware and the video codecs installed.

What about scheduling recordings? MyHD uses TitanTV as its primary TV guide. The good news is that MyHD is well integrated with TitanTV, and you can easily set up one-click recording of shows. If you decide to download up to eight days' worth of guide information to your PC, you can also use the guide software within the MyHD 120's on-screen display.

The bad news is that you need to set up a favorite show list within TitanTV before you can download the information—a one-time task. TitanTV's interface is more streamlined than the last time we tried it: The pop-up screens for scheduling are easy to understand, once you get used to the fairly tiny icons. But be prepared: When you schedule a show, you end up inside a MyHD scheduling dialog, which looks completely different than the cleaner TitanTV interface.





Overlay Window
Aspect Ratio
☐ Fixed Aspect Ratio
Window Aspect Ratio
Overlay Mode
VOP 30 fields/sec
☐ Keep Video on Top
☑ Show Overlay Window
☐ Show OSD on Overlay
Miscellaneous
Channel Display
☑ Show Channel Number
☐ Show Channel Name
☐ Using Separate Monitor
☑ Set MyHD Process Priority High
☐ Start with Last Input Mode
☐ Turn off the Computer when closing MyHD by Remote Controller
☐ Start with HD Mode
☑ Clip Mouse Cursor in HD Mode
☐ Enable Digital Flat Panel Mode Output
☑ Using TitanTV Epg

WATCH THIS
TitanTV has a clean, usable interface, as seen above. It ain't TiVo, but it's pretty good. The MyHD card's setup, on the other hand, is confusing as all get out. Check out the "VGA setup" menu at right.

Once you get used to the system, recording shows is straightforward. What's not straightforward is what occurs afterwards. First comes an unfortunate bug in MyHD that can cause it to lock up during recording, if you have a CPU with Hyper-Threading and the Hyper-Threading is enabled. This affects many current Pentium 4 systems. Additionally, playing TP files we recorded was an iffy process. Sometimes we would get a black screen within the MyHD player, though the time indicator was moving. Sometimes we'd get video but no audio. Sometimes the system would lock up hard. Macro Image Technology has been releasing software updates at a steady pace, but we certainly haven't been encouraged by the lack of stability in the record and playback software.

Viewing Considerations

The MyHD 120 card worked quite well as an HDTV source, but viewing perfection was still somewhat elusive. Initially we used the DVI daughterboard, but the DVI connection on the Samsung DLP TV fed oddball information to the PC as to its capabilities. If you want to use DVI, you're best bet is to download a utility like PowerStrip to tweak your monitor timings. It's a labor-intensive effort, but you'll be rewarded with a great-looking picture. If you simply want to plug and play, however, there's an easier solution: Use the VGA input.

It may seem like a step backward to use an analog connection to view digital television that's running on a PC, but this worked out of the box for us. We did have to use PowerStrip for one thing: to permit 1,280-by-720 resolution on ATI hardware. The Catalyst 3.6 drivers we tested didn't have a built-in setting for 1,280-by-720, but several newer iterations have come out since. If you're using an nVidia card, then you'll find 1,280-by-720 as an available resolution in the last few driver releases.

In either case, viewing HDTV content was stunning. We caught a Tori Amos concert on the local PBS feed, and the image quality was amazing when compared with that of standard TV. But we were ultimately disappointed with the MyHD 120 card itself, which does however show a lot of promise. The core of a great off-the-air HDTV recording solution exists. The hardware works well, and image quality was excellent, even with relatively weak signals. But the company really needs to work out the bugs in the recording software before we can recommend it for recording HDTV content. Keep your fingers crossed for future driver updates. **X**

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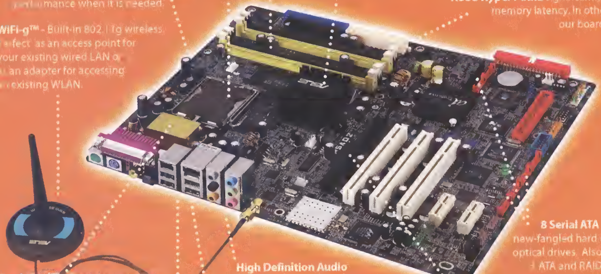

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Two 1394b Firewire 800, a 1394a, Dual Gigabit LAN, and 8 USB 2.0 ports.
Excessive? We don't think so either.

Maximum PC "Dream PC 2004" Motherboard
"P5AD2 Premium is the easily the most over-the-top mobo package we've ever seen."
Anandtech.com "Gold Editor's Choice"
"... the best overclocking abilities of any 925X motherboard ..."
www.motherboards.org "96/100 Score Earns Editor's Choice"
"The P5AD2 Premium is the most fully featured MB available."

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P5AD2 Premium - Extreme Overkill

The average PC user won't appreciate the over-the-top performance and extravagant amount of bleeding-edge technolgy. But we knew you'd understand.

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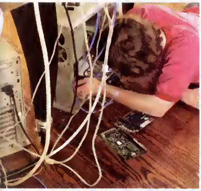
BUILD YOUR OWN

HOME LINUX SERVER

Looking for a place to put all those CD rips, pictures, Web pages, and other digital sundries? We'll show you the best way to build your home network nerve center. / Dave Salvator



GETTY IMAGES

1979 WAS A GOOD YEAR

Back then everyone built their own PCs, and a command-line interface wasn't such a scary thing. Build yourself a Linux server and bring yourself back to that command-line fun. Just don't feather your hair again, okay?

It's been some time coming. After all, your home network, a hodgepodge of peer-to-peer machines, has been crying out for a nerve center where files live and services are at the ready—a machine that will dutifully keep it all going 24/7 with minimal fuss. A machine to grow with you as your needs get more sophisticated. Linux continues to gain ground in the enterprise server space, with champions in HP, IBM, and Sun. And though it has proven its mettle driving big iron, Linux is equally well suited to powering your home server.

For about $600, you can build a very capable server with gobs of storage and enough processing horsepower to pull multiple duties serving up a printer queue, Web pages, Samba, and more. If you've got some old parts to scavenge and are working within a tight budget, you can even put together a solid server for under $400. Heck, an old box you're looking to put out to pasture can even be a serviceable server. Let's start with our recipe for a new box, and then we'll compare it to a few alternatives.

Tech Toolbox
What You Need

	The Product	The Skinny	Price
Case	Antec LANboy	ATX, easy access, no busted knuckles	$70
Power Supply	SmartBlue 350	350-Watt ATX12V model	included with case
CPU	Pentium 4 2.4 GHz	1MB L2 cache, 800-MHz FSB	$170
Motherboard	Intel 865GBF	on-board LAN, graphics, Serial ATA, audio, and USB 2.0	$90
System Memory	Kingston ValueRAM DDR PC-3200	256MB; it remembers	$50
Graphics Card	Intel Extreme Graphics 2	Integrated into motherboard	$0
CD Burner	Lite-On LTR-52327S	CD-R/RW	$27
Hard Drive	Western Digital WD1200JB	120GB drive for data volume w/8MB onboard cache	$85
Display	ViewSonic Q51 Optiquest	14" monitor	$110
Keyboard and Mouse	Logitech Access Duo	Good basic keyboard/mouse combo	$27
OS	Xandros Open Circulation	Great first Linux distro, very Windows-like	$0
Total			$629

Prices shown are estimates before tax and shipping based on our price-comparison engine, *extremetech.shopping.com.*

Build a Server

For a system that will primarily serve up files and a print queue, you don't need barn-burning components: The idea is *fast enough* rather than top of the line. For just over $600, we've actually put together a very solid load-out that includes adequate CPU horsepower and a hearty 120GB bit bucket that all your Windows PCs (and Macs too) can access on your home network. If you have an old monitor, keyboard, and mouse you can mate with this system, the price tag drops below $500.

For the Linux distribution, we went with Xandros's new Open Circulation version (Xandros OC), which is available for free download via BitTorrent. (Lawyers take note: We swear we've never used BitTorrent to download television shows.) Xandros is a terrific Linux distribution for those more familiar with Windows because of its Windows-like functionality. For instance, to set up a shared folder, all you have to do is right-click on it and enable sharing. Of course, if you're more comfortable with another distribution like Debian, Fedora Core (the free version of RedHat), Mandrake, or SuSE, then go with what you know. But if you're new to Linux and don't want to spend a lot of time twiddling with config files, Xandros is a great place to start.

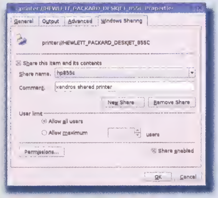
Different Routes, Same Destination

Usually, a file server is a machine you want to tuck away in the corner of your office or somewhere out of the way. The Antec LANboy case we used is compact, but you may want a server that's more compact still. Small-form-factor PCs have become the darlings of the LAN party set, and with good reason. With them, you can stuff a whole lot of horsepower into a small box that you can easily cart under one arm. What's not to like, right? Well there are a few downsides to having a box like this act as a server.

XTIPS

- **Administering your server remotely** over the Internet is simple using a program like Webmin (*www.webmin.com*). Using any browser that supports tables and forms, you can set user accounts, change file sharing, and so on.
- **Looking to add PVR capabilities** to your box? MythTV (*www.mythtv.org*) is a popular, highly configurable package that also plays back music, photos, and videos. It even includes a weather module.
- **Watch the gap!** Spaces in file names, while perfectly acceptable in the world of Microsoft Windows, can cause headaches in other operating systems. Use underscores or capitalization to distinguish words instead.

The first issue is cost. Using a bare-bones micro-ATX system from Shuttle with an Intel 865G chipset that has integrated graphics will add about $180 to the overall cost of the server. Another consideration is noise. Shuttle and other small PC makers have implemented variable-speed fans to keep things cool inside their cramped cases, but if you tax the server's CPU it may start emitting more fan noise than you want from your server. The upside lies in the compact shape itself: You get a server that's very easy to tuck in a remote corner of your house. This convenience adds a whopping 25 percent to the server's overall cost, however. If you're on a tight budget, you should consider putting those $180 dollars to better use.



printer://HEWLETT_PACKARD_DESKJET_855C

☒ Share this item and its contents

Share name: hp855c

Comment: xandros shared printer

User limit

● Allow all users

○ Allow maximum users

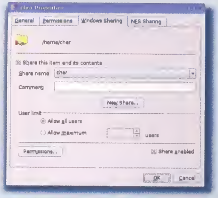
☒ Share enabled

YOUR PRINTS LOOK CHARMING when you share your local printer, name it logically, like *HP printer,* rather than, say, *Tony.*

Another really good option is to survey the systems you're currently running at home and retire the oldest system into serverhood. If you've got an older Pentium-III or even Pentium-II-class system that's wheezing as a desktop rig, with a bit more memory and a decent-sized hard drive, it could be repurposed into a fine home server, and you could take the money saved and invest in new desktop system hardware. That way you'll only have to spend about $85 (the cost of a new, bigger hard drive) for the system. You'll want to increase system memory to at least 256MB as well, but even with these two upgrades, your total cost will still be well under $150. If you can budget more for this server and have an older system you can repurpose, you're left with some found funds to build a new midrange system for gaming and whatever else suits your computing tastes.

Why Xandros?

Now we come to the part of the program that could start a fistfight in some Bay Area brewpubs: which Linux distro is the best for your home server? The answer, as mealy-mouthed as it may seem is, it depends. If you've logged many moons with one specific distro and know its high points as well as its warts, then you'll probably want to put that knowledge to good use. If you're a grizzled Linux/Unix vet, you may just want to run a command-line version of FreeBSD and not even bother running X-windows to conserve those CPU cycles for server-related tasks.



/home/cher

☒ Share this item and its contents

Share name: cher

Comment:

User limit

● Allow all users

○ Allow maximum users

☒ Share enabled

SET YOUR FILES FREE

You can even set up dedicated folders for every member of your household.

If you're a Linux newbie, on the other hand, you'd do well to consider one of the more commercialized packages, like SuSE, Red Hat, or Xandros. Given the degree of polish in these packages lately, they obviate Lindows, because they deliver much of the same ease-of-use as Lindows, but without the $99 per year price-tag.

If we had to define Xandros with one word, we'd pick "usable." The folks at Xandros have refined their product significantly and come up with something that makes Linux quite comfortable and easy to use, even if you're a total newbie to the OS. But the choice of distro is a personal one, and one size does not fit all. So, depending on your particular knowledge level and preferences, choose the distro that you feel comfortable with, and let's move on to the working with this beast.

Setting Up a Shared Printer

After Xandros's installer has copied all of the needed files to your hard drive, you'll be prompted to add a printer during the initial boot-up. We suggest logging in as root to finish these system-configuration chores. We used an HP DeskJet 855C for this test, and Xandros detected an HP 850C DeskJet printer. The 855C was on its list of supported printers, so we changed the entry and all was well. Be sure your printer is connected when you're installing Xandros OC, and verify that the OS has detected the correct make and model for the printer during initial boot-up.

Next, you'll want to go into Xandros OC's Control Center application—which is like Windows Control Panel—and click on the Printers icon. There you should see your printer listed. Double-click on it, and go to the Windows Sharing tab of its Properties sheet. Click on the ballot box labeled "Share this item and its contents." Then give the printer a simple share name; we used *hp855c*.

We did hit one minor snag in this process. We had to enter an address for our printer manually from a Windows machine in order to see the printer queue. This took the form of *\\xandros\hp855c* as the address for our printer queue. But when we entered this address and Windows loaded a driver for the printer, we could print with ease from all the Windows machines on our network.

Now we come to the part of the program that could start a fistfight in some Bay Area brewpubs: which Linux distro is the best for your home server?

Setting Up a Shared Folder

File sharing is as easy in Xandros as it is in Windows. We suggest creating a folder in the *\home* subfolder and then enabling sharing on that folder and that folder only. Though it's nice to share, it's also sometimes wise not to share too much. Be sure that you share only folders you want other people to have access to. Don't share a folder such as *\root*, because someone could accidentally (or not) trash your server.

We created a subfolder called Cher, where we copied some files and enabled sharing. To do this, simply right-click on the subfolder and select Sharing, and then click on Windows Sharing. From there, click on the ballot box labeled "Share this item and its contents." Give the folder a simple share name; as you can see in the screen shot, we've named our share *cher*. Clever, eh?

You can set up dedicated folders for every member of your household, so that only you and that family member can see the folder's contents. To do this, however, you'll need to create user accounts on the Xandros OC machine so that each person can log on to the network and then access his or her designated folder.

Last, we strongly suggest that once you've gotten your shares set up you log out from Xandros as root and log back on as a nonsuperuser. That way, if someone is using the system for Web surfing or office applications, they can't accidentally hose any of your system settings.

Serve It Up

Even though your new server's primary mission in life is to serve up files and host a printer, that doesn't mean you can't also use it as a desktop system running office applications (Xandros OC conveniently comes with OpenOffice) and Web browsers. Computationally intensive tasks like CD ripping and media encoding are probably better left to your beefier systems, but this system is also up to the task. It won't plow through them as fast as your hot-rod rig, that's all. But given inexpensive, solid hardware and an easy (and free) Linux distribution like Xandros OC, your home's file/print server is just a half a day's work away. **X**

THE OUTER LIMITS

Geeks Just Wanna Have Fun / Loyd Case

Recently a lightbulb went off in my head. It glowed an ethereal, soft blue—like the all-acrylic MGE case that inspired me. I would build a glowing PC! But not just a PC with colored lights attached. Everyone's seen systems that pump out enough light to challenge daylight…if daylight glowed in multiple colors on an alien planet with more than one sun, that is. I just didn't want to build something that was painful to look at: I wanted something that gave a nod—or at least a bare *glance*—at good taste.

Motherboard

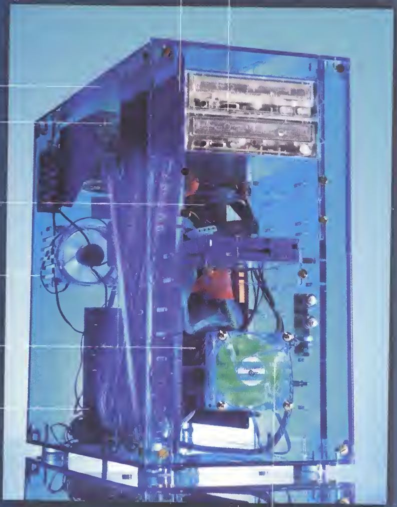
The system was built around a 3.0-GHz Intel Pentium 4 CPU (code-named Northwood). Why a Pentium 4? We had a spare one available. The motherboard was much more important anyway. DFI offers the LanParty line, which uses UV-sensitive components for the PCI slots and other connectors. The kind folks there offered a Pro875B for this little project.

DVD Drives

We needed an optical drive or two. Fortunately, Artec makes 'em with translucent bezels and trays, complete with blue LED activity lights.

Case

This MGE case is made of UV-sensitive acrylic, like your basic black light. We like UV cold cathode lights that glow indirectly, rather than being bright themselves. So we began with a pair of Vantec Spectrum UV cold cathode tubes.



CHRIS STEIN

Power Supply

This system deserved more than a run-of-the-mill PS. This TTGI Super Flower 450W comes with a mirror finish (green in this case) and a glowing LED inside the power supply. And the large, slow-turning fan keeps things fairly quiet.

Hard Drive

We used a Seagate 160GB Serial ATA drive. SATA cables are thinner than IDE cables, and Coolmax sells some with electroluminescent wiring wound through them. The company makes a floppy disk cable with EL wiring too. Naturally we used both.

CPU Cooler

Is the Coolermaster Aero 4 an exceptional cooler? It certainly does the job at standard clock rates. Given its design, it's probably not that great for overclocking. But then, that's not the point here. It looks spiffy—that's the point.

RAM

The memory was supplied by Corsair, which sent us a pair of XMS Pro modules. They have a set of activity LEDs along the top of the heat spreader. Very cool.

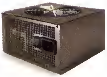
Graphics Card

For graphics, we found the Gainward Ultra/1800 GeForce FX 5950, which has two cooling fans and—of course!—two glowing blue LEDs. This part's a bit silly: You can't actually see the LEDs, since they face downward.

Case Fans

Now we turn to peripherals that generate light. First up was a pair of cold cathode UV tubes from Vantec's Spectrum line. We also used a pair of Vantec fans, with round, cold cathode UV tubes attached. The top case fan was part of Memorex's Modz line. A simple, blue-glowing LED graces it, but we also added a Coolmax fan cover with an embedded UV cold cathode.

Do you have any modified or custom-rigged cases? Drop us an e-mail at letters@extremetech.com and let us know. Be sure to send pictures!



The thrill of victory was never quite so scintillating. The cutting edge features of Antec's NeoPower let you take maximum advantage of all the latest technology – now. Like an advanced cable management system. Native support for PCI-Express graphics cards. Full ATX12V v2.0 compliance. Plus 480 Watts of supremely stable power with a single 120mm fan for virtually silent operation. And that's just the beginning. For the complete story on NeoPower 480 visit www.antec.com or your local Antec retailer today.

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The Power of You

Spector Pro

NEW!
Version 5.0

Record EVERYTHING They Do Online.

How Does Spector Pro Work?

Install Spector Pro on your PC and it will record EVERYTHING your spouse, kids and employees do on the Internet. Spector Pro is the world's best selling software for monitoring and recording every detail of PC and Internet activity.

Seven Recording Tools Work Together

Spector Pro contains seven integrated tools that record: chats, instant messages, emails sent and received, web sites visited, keystrokes typed, programs launched, peer to peer file searching and swapping – plus, Spector Pro provides the equivalent of a digital surveillance tape so that you can see the EXACT sequence of EVERYTHING your family members or employees are doing on the computer. All seven tools work together at the same time, saving all the recordings in a hidden location only you know about.

NEW! - Internet Access Blocking

Spector Pro not only records almost every kind of Internet activity imaginable, but it also allows you to block access to specific web sites, chat applications and other programs and even gives you the power to restrict access on a schedule. Want to block the kids from chatting online after school? Easy. Keep them off AOL after 9:00 PM? No Problem. Block access to sex.com forever? Done.

Spector Pro at Home

Spector Pro records EVERYTHING your kids do on the Internet. You will always have a COMPLETE VISUAL record of their online activity, giving you peace of mind even for those times when you can't be around to supervise. And, if you believe your spouse is using the Internet inappropriately, there is no faster or more accurate way to find out than with Spector Pro.

Spector Pro at the Office

Are your employees working when they're online or are they playing in chat rooms, on auction sites, checking sports scores and stock quotes, or doing personal email? Are they spreading company confidential information via anonymous email accounts and message boards? Spector Pro records every EXACT DETAIL of their activity, from the moment they logon to the second they log off at the end of the day.

Two Time Winner of PC Magazine Editors' Choice

Spector Pro was first awarded PC Magazine Editors' Choice in July 2002 as the best Internet monitoring software for recording PC activity. In its August 3, 2004 issue, PC Magazine once again bestowed its top honor upon Spector Pro by proclaiming it to "offer the most powerful and complete assortment of monitoring and reporting features".

PC MAGAZINE EDITORS' CHOICE
August 3, 2004
Spector Pro 5.0

Spector Pro Automatically Records

Email (Sent & Received)
- Records SMTP/POP3 (e.g. MS Outlook, etc.), MS Exchange and Proprietary AOL Email
- Records Hotmail, Yahoo, AOL, ATT Worldnet, NetZero and Netscape web-based Email
- View/Open File Attachments

Chats/Instant Messages
- Records AOL Chat Rooms
- Records AOL Instant Messenger (AIM)
- Records MSN Instant Messenger
- Records Yahoo Messenger
- Records ICQ, IRC, Trillian and more.

Keystrokes Typed
- Records ALL Typed Keystrokes
- Records Hidden Characters and Passwords Typed

Web Sites & File Downloads
- Records Domain Names and Specific URLs Visited
- Record Files Downloaded (via the Internet or accessed over the network)
- Block Future Access to URLs with a Single Click
- View Date/Time, Total Duration and Total Number of Web Site Visits

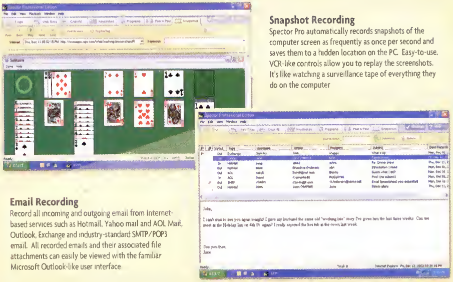
Program Activity
- Record every Program launched on the PC
- View the Total Amount of Time a Program was Actively being used

Peer to Peer File Swapping
- Records Kazaa & Kazaa Lite
- Records Gnucleus, Limewire and other programs that use the Gnutella file sharing engine
- View the text of all Peer to Peer program searches
- View the name of all Peer to Peer file downloads

Screen Snapshots
- VCR Style Playback
- Fast Forward/Immediate Rewind

Snapshot Recording

Spector Pro automatically records snapshots of the computer screen as frequently as once per second and saves them to a hidden location on the PC. Easy-to-use, VCR-like controls allow you to replay the screenshots. It's like watching a surveillance tape of everything they do on the computer.



John,

I can't wait to see you again tonight! I gave my husband the same old "working late" story I've given him the last three weeks. Can we meet at the Holiday Inn on 4th St. again? I really enjoyed the hot tub in the room last week.

See you then,
Jane

Email Recording

Record all incoming and outgoing email from Internet-based services such as Hotmail, Yahoo mail and AOL Mail, Outlook, Exchange and industry-standard SMTP/POP3 email. All recorded emails and their associated file attachments can easily be viewed with the familiar Microsoft Outlook-like user interface.

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